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NAVIGATION CONDITIONS AT JOHN H. OVERTON LOCK AND DAM, RED RIVE--ETC(U)
MAR 79 L J SHOWS, J J FRANCO

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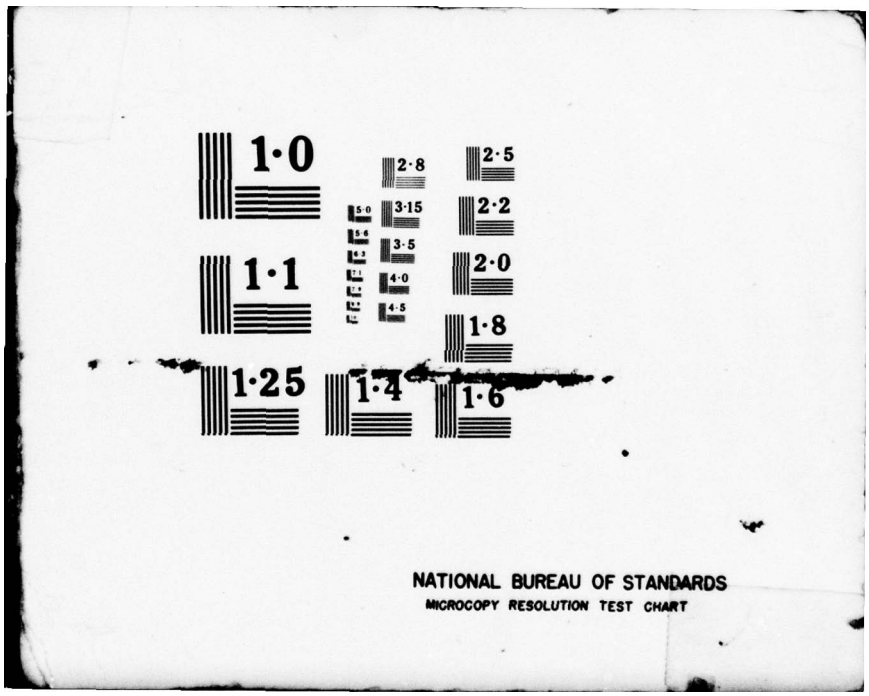
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LEVEL II

TECHNICAL REPORT HL-79-3

NAVIGATION CONDITIONS AT JOHN H. OVERTON LOCK AND DAM RED RIVER

Hydraulic Model Investigation

by

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March 1979

Final Report

Approved For Public Release; Distribution Unlimited

Prepared for U. S. Army Engineer District, New Orleans
New Orleans, Louisiana 70160

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The John H. Overton Lock and Dam will be the second navigation structure proposed for the development of navigation on the Red River waterways. The structure will be located in a cutoff channel in the left overbank about 74 realigned channel miles above the Mississippi River. The structure will include one lock located along the left bank with clear chamber dimensions of 84 by 785 ft and a dam consisting of a spillway with seven 50-ft-wide gates and a

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20. ABSTRACT (Continued).

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330-ft-long fixed-crest overflow weir designed to maintain during low flows a minimum upper pool at el 58.0 extending upstream about 37.5 miles to the proposed Lock and Dam 3.

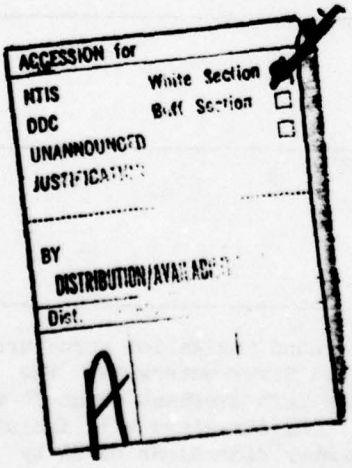
A semifixed-bed model reproducing about 3.7 miles of the Red River channel and adjacent overbank areas to an undistorted scale of 1:100 was used to provide some general information on navigation conditions with the proposed design and to develop such modifications as might be required to eliminate conditions that would adversely affect navigation using the lock. Results of the investigation ~~revealed the following:~~ are included in the report.

a. Satisfactory navigation conditions in the upper lock approach could be developed with modification of the excavation along the left bank of the approach channel and extending the length of the upper guard wall.

b. The length of the overflow weir and excavation along the right bank of the cutoff channel could be reduced without affecting navigation conditions in the lock approaches or flow through the dam.

c. Satisfactory navigation conditions could be developed in the lower lock approach with either a floating guide wall (land side) or a guard wall (river side). Conditions for two-way traffic would be better with the guide wall.

d. The differences in the water-surface elevations across the dam with plans tested would tend to be small.



31 channel miles above Lock and Dam 1. The lock and dam will be the second navigation structure above the mouth of the Red River. The general design of Lock and Dam 2 consists of an 84- by 785-ft navigation lock with an adjacent spillway containing seven 50-ft-wide gates and a 330-ft overflow weir. The structures will provide a normal upper pool at el 58.0* with a normal lift of 18 ft in the lock chamber from Lock and Dam 1 pool at el 40.0. The lock will be located on the left side of the cutoff canal with the gated spillway to the right adjacent to the lock, and an overflow weir with top elevation of 60.0 connecting the spillway to the right bank of the cutoff canal.

Need for and Purpose of Model Study

6. The general design of Lock and Dam 2 was based on sound theoretical design practice and experience with similar structures. However, navigation conditions vary with location and flow conditions upstream and downstream of a structure, and an analytical study to determine the hydraulic effects that can reasonably be expected to result from a particular design is both difficult and inconclusive. Since Lock and Dam 2 was to be located in an excavated canal bypassing a sharp bend, it was important that the alignment of the canal and the arrangement of the lock and dam be satisfactory for navigation. Therefore, a comprehensive model study was considered necessary to investigate conditions that could be expected with the proposed design and to develop modifications required to ensure satisfactory navigation conditions. The specific purposes of the model study were:

a. To determine the adequacy of the alignment and amount of excavation proposed for the bypass canal and the arrangement of the lock, lock auxiliary walls, and dam.

b. To develop modifications required to provide satisfactory navigation conditions and minimize construction.

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* All elevations (el) cited herein are in feet referred to mean sea level (msl).

c. To provide data for use in a movable-bed study to determine the effects of the changes on the movement of sediment and its effects on channel width and depth.

d. To demonstrate to navigation interests the conditions resulting from the proposed design, and to satisfy these interests of its acceptability from a navigation standpoint.

PREFACE

The model investigation reported herein was authorized by the Office, Chief of Engineers, U. S. Army, in 2nd Indorsement dated 17 July 1973 to the Division Engineer, Lower Mississippi Valley (LMVD). The study was conducted for the U. S. Army Engineer District, New Orleans (LMN) and coordinated by the U. S. Army Engineer District, St. Louis (LMS) in the Hydraulics Laboratory of the U. S. Army Engineer Waterways Experiment Station (WES) during the period September 1976 to January 1978.

The investigation was conducted under the general supervision of Mr. H. B. Simmons, Chief of the Hydraulics Laboratory, and Mr. F. A. Herrmann, Jr., Assistant Chief of the Hydraulics Laboratory, and under the direct supervision of Mr. J. E. Glover, Chief of the Waterways Division. The engineer in immediate charge of the model was Mr. L. J. Shows, Chief of the Navigation Branch, assisted by Messrs. T. H. Kyzar and R. T. Wooley. This report was prepared by Messrs. Shows and J. J. Franco.

During the course of the model study, representatives from the LMVD, LMN, and the LMS visited WES at different times to observe special model tests and discuss the results. The LMN was kept informed of the progress of the study through monthly progress reports and special reports at the end of each test.

Commander and Director of WES during the course of the investigation and the preparation and publication of this report was COL John L. Cannon, CE. Technical Director was Mr. F. R. Brown.

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CONVERSION FACTORS, U. S. CUSTOMARY TO METRIC (SI)
UNITS OF MEASUREMENT

U. S. customary units of measurment used in this report can be converted to metric (SI) units as follows:

Multiply	By	To Obtain
cubic feet per second	0.02831685	cubic metres per second
feet	0.3048	metres
feet per second	0.3048	metres per second
miles (U. S. statute)	1.609344	kilometres

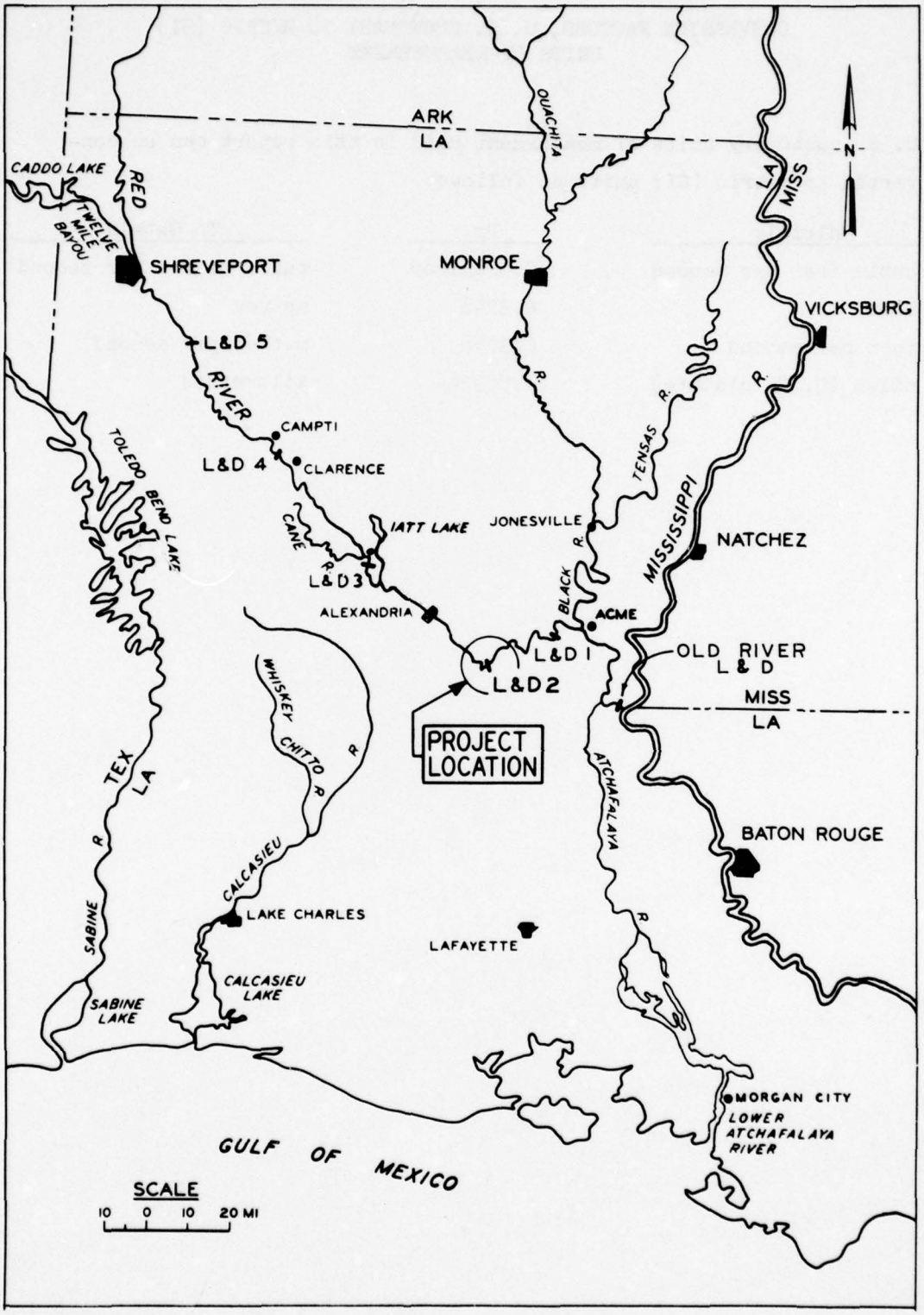

Figure 1. Location map

NAVIGATION CONDITIONS AT JOHN H. OVERTON LOCK AND DAM, RED RIVER

Hydraulic Model Investigation

PART I: INTRODUCTION

Present Development Plan and Description of Prototype*

1. As presently authorized, the Red River multipurpose project provides for the improvement of the Red River and its tributaries in Louisiana, Arkansas, Texas, and Oklahoma through coordinated developments for navigation, bank stabilization, flood control, recreation, fish and wildlife, and water quality control. The project consists of four distinct reaches: (a) Mississippi River to Shreveport, Louisiana; (b) Shreveport, Louisiana, to Dangerfield, Texas, by Twelve Mile Bayou; (c) Shreveport, Louisiana, to Index, Arkansas; and (d) Index, Arkansas, to Denison Dam, Texas. Only the first reach (Figure 1) is pertinent to this report. Within the first reach, the plan provides for establishing a navigable channel, approximately 227 miles** long, 9 ft deep with minimum width of 200 ft, from the vicinity of Old River by means of a system of five locks and dams, that connects with the Mississippi River through the Old River Lock and Dam (Figure 1).

2. From Denison Dam, the Red River follows an easterly course along the southern edge of Oklahoma, forming the boundary between that state and Texas, and continues eastward some 47 miles farther to Index, Texas-Arkansas, forming the boundary between Texas and Arkansas. Continuing through Arkansas a short distance beyond Index to Fulton, Arkansas, the river then turns abruptly and follows a southerly course for some 77 miles to the Arkansas-Louisiana State line. The remainder of

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* Prototype information was obtained from John H. Overton Lock and Dam Memorandum No. 18, dated May 1977.

** A table of factors for converting metric (SI) units of measurement to U. S. customary units is presented on page 3.

its course lies within the State of Louisiana. At Shreveport, it shifts to a southeasterly direction for some 160 miles to its mouth at the junction with the Atchafalaya River and Old River, 7 miles from the confluence of Old River and the Mississippi River at Red River Landing. Since 1963, flow from the Mississippi River into the Atchafalaya system has been regulated by control structures near the Mississippi River levee line where an excavated channel carries outflow to the lower Red River. A 75-ft-wide by 1,200-ft-long lock at the mouth of Old River provides for navigation between the Mississippi and the Red-Atchafalaya Rivers via the Old River channel.

3. From Alexandria to its mouth, the Red River traverses the floodplain of the Mississippi River. On the right (south) bank, from the hills above Alexandria to high ground at Moncla, Louisiana, a levee that is part of the Lower Mississippi River Levee System protects the alluvial lands south of the Red River and west of the Atchafalaya Floodway. From Moncla to Lake Long, a local levee provides partial protection from headwater overflows. The banks rise 35 to 40 ft above low water and in general are 700 to 800 ft apart. The slope of the water surface below Alexandria is dependent upon the stage in the Red River backwater area as affected by operation of Old River Control Structure.

4. Public Law 90-483, 90th Congress, approved 13 August 1968, authorized the construction of the "Red River Waterway, Louisiana, Texas, Arkansas, and Oklahoma, Project," in accordance with the recommendations of the Chief of Engineers as contained in House Document No. 304, 90th Congress, 2nd Session. The Appropriations Act of 1971, approved 7 October 1970, as Public Law 91-439, provides the authority to initiate preconstruction planning from the Mississippi River to Shreveport, Louisiana, reach of the project.

Lock and Dam 2 (John H. Overton Lock and Dam)

5. Lock and Dam 2 is proposed for construction in a cutoff canal approximately 74 miles* above the Mississippi River, and about

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* Unless otherwise stated, river miles are along the channel based on the proposed realignment.

PART II: THE MODEL

Description

7. The model (Figure 2) reproduced about 3.7 miles of the Red River channel as realigned and adjacent overbank areas (between miles 90.1 and 85.6*) extending approximately 9,300 ft upstream of the lock and dam and 10,250 ft downstream. The model was of the semifixed-bed type, located in a flume 55 ft wide and 200 ft long, with the channel and overbank areas molded in pea gravel to sheet-metal templates to permit modifications as required. The lock, dam crest, piers, guard walls, and overflow weir were fabricated of sheet metal. The dam gates were simulated schematically with simple sheet-metal slide-type gates.

8. The model was molded to a combination of the hydrographic survey made in 1967-1968, the Whittington Revetment Survey made in September 1976, and the Hog Lake Revetment Survey made in April 1975.

Scale Relations

9. The model was built to an undistorted linear scale ratio of 1:100, model to prototype, to obtain accurate reproduction of velocities, crosscurrents, and eddies that would affect navigation. Other scale ratios resulting from the linear scale ratio were as follows:

Area	1:10,000
Velocity	1:10
Time	1:10
Discharge	1:100,000
Roughness (Manning's n)	1:2.15

Measurements of discharges, water-surface elevations, and current velocities can be transferred quantitatively from model to prototype equivalents by means of these scale relations.

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* River miles above Mississippi River are based on aerial photographs flown in 1967.

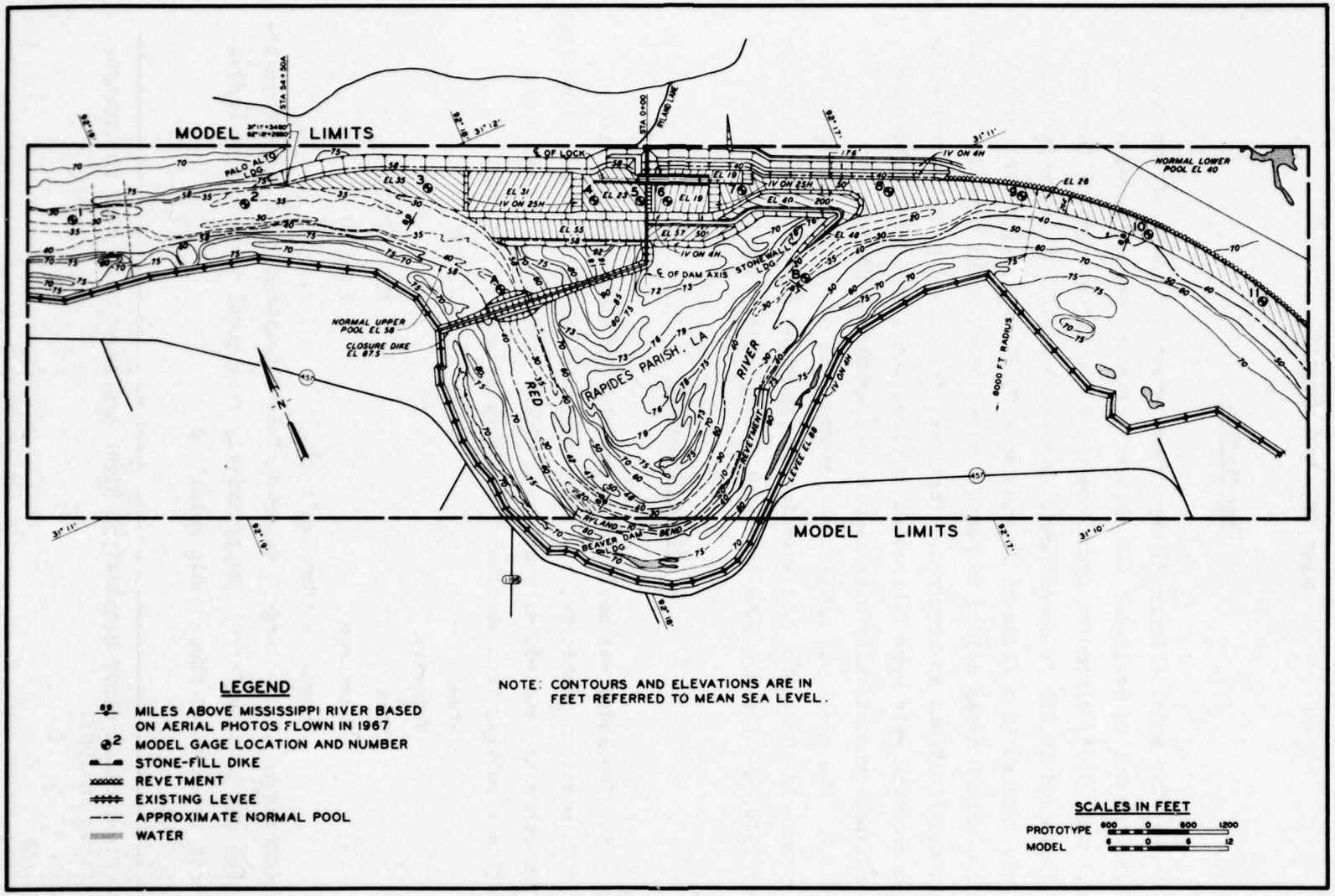


Figure 2. Model layout and location of gages

Appurtenances

10. Water was supplied to the model by means of a 10-cfs pump operating in a circulating system. The discharge was controlled and measured at the upper end of the model by means of valves and venturi meters. Water-surface elevations were measured by means of piezometer gages located in the model channel and connected to a centrally located gage pit (Figure 2). A tailgate was provided at the lower end of the model to control the tailwater elevation downstream of the dam and the slide-type gates in the spillway were used to maintain the upper pool elevation during controlled flows.

11. Velocities and current directions were determined in the model by means of wooden cylinder floats weighted on one end to simulate the maximum permissible draft for loaded barges using the waterway (9 ft prototype). A model towboat and tow were used to determine and demonstrate the effects of currents on tows approaching and leaving the lock (Figure 3). The overall size of the towboat and tow used in the

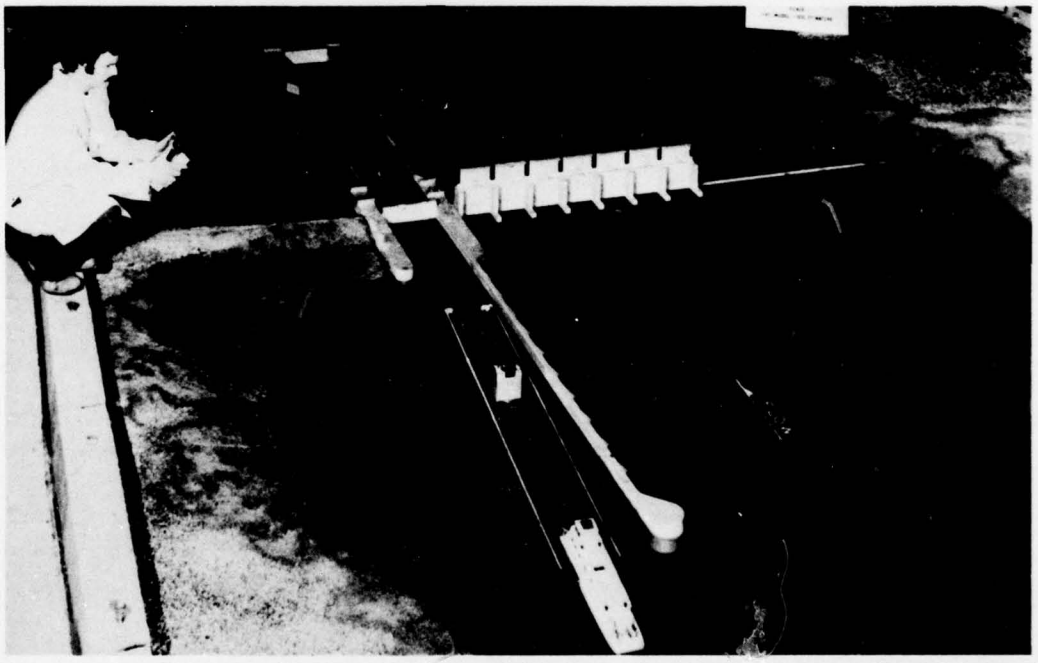


Figure 3. Remote-controlled towboat and tow approaching the upper guard wall

study was 685 ft long by 70 ft wide loaded to a draft of 9 ft. The towboat was equipped with twin screws and was propelled by two small electric motors operating from batteries located in the tow; the rudders and speed of the tow were remote-controlled. The towboat could be operated in forward or reverse with the power adjusted by means of a rheostat to a maximum speed comparable to that of the towboats expected to use the Red River waterways.

Model Adjustment

12. Inclusion of the proposed lock and dam plans in the initial model construction precluded adjustment of the model to the existing prototype conditions. This type of adjustment was not considered necessary since the proposed improvements would involve considerable change from existing conditions. The model was constructed with pea gravel to provide a roughness factor (Manning's n) which corresponds to prototype channel roughness of about 0.035.

PART III: TESTS AND RESULTS

Test Procedures

13. Tests on the model were concerned primarily with the study of flow patterns, measurements of velocities and water-surface elevations, and the effects of currents on the movement of the model tow entering and leaving the cutoff canal and within the lock approaches with various riverflows. Since the worst conditions for navigation were obtained on the model during the higher river stages with uncontrolled riverflows, no tests were conducted to determine the effects of dam gate operation other than with flow distributed uniformly over the entire length of the dam.

14. The following representative flows were used for testing based on information furnished by the U. S. Army Engineer District, New Orleans (LMN):

a. A controlled riverflow of 31,000 cfs with normal upper pool elevation of 58.0 (average annual flow).

b. Maximum flow at which normal pool el 58.0 could be maintained at the dam (discharge varied with modification of tailwater rating curve).

c. An intermediate uncontrolled flow of 110,000 cfs.

d. The maximum navigable flow of 145,000 cfs.

15. The controlled riverflow was reproduced by introducing the proper discharge, setting the tailwater elevation for the discharge, and manipulating the dam gate openings until the required upper pool elevation was obtained. Uncontrolled riverflows were reproduced by introducing the proper discharge with dam gates fully open and manipulating the tailgate to obtain the proper tailwater elevation below the dam. All stages were permitted to stabilize before data were recorded. Velocities were determined by timing the travel of a float (described in paragraph 11) over a measured distance. Current directions were determined by plotting the paths of the floats with respect to ranges established for that purpose. In the plots of currents in turbulent areas or where eddies or crosscurrents existed, only the main trends

are shown in the interest of clarity. No data were obtained with the model tows other than observations of their behavior in the lock approaches and through the upper and lower pools.

16. Most of the modifications were developed during preliminary tests. Data obtained during these tests were sufficient only to assist in the development of plans that appeared to produce the improvements desired. Results of the preliminary tests are not included in this report.

Original Design

Description

17. The original plan proposed for the lock and dam and the bypass channel is shown in Figures 4 and 5 and included the following principal features:

a. A nonnavigable gated spillway, an overflow weir, and a lock located in the cutoff channel. The lock located along the left bank of the bypass channel had clear chamber dimensions of 84 ft by 785 ft, a 650-ft-long ported cellular-type upper guard wall, and a 650-ft-long nonported lower guard wall with the top of the lock walls at el 74.5.

b. The spillway adjacent to the lock contained seven 50-ft-wide gate bays and eight 8-ft-wide piers with gate sills at el 28.0.

c. A 420-ft-long overflow weir with crest elevation of 60.0 extended from the gated spillway to the right overbank. A closure dike extended from the right abutment of the overflow weir across the right overbank and upper reach of the existing bendway channel.

d. The excavated channel bottom adjacent to the gated spillway was at el 23.0 on the upstream side and at el 19.0 on the downstream side. The channel bottom adjacent to the overflow weir was at el 55.0 on the upstream side and at el 57.0 on the downstream side.

e. The excavated channel bottom approaching the lock was at el 35.0 and 31.0 upstream of the upper guard wall and el 26.0 downstream of the lower guard wall with a bottom width of 176 ft.

f. The existing channel downstream of the bypass canal was

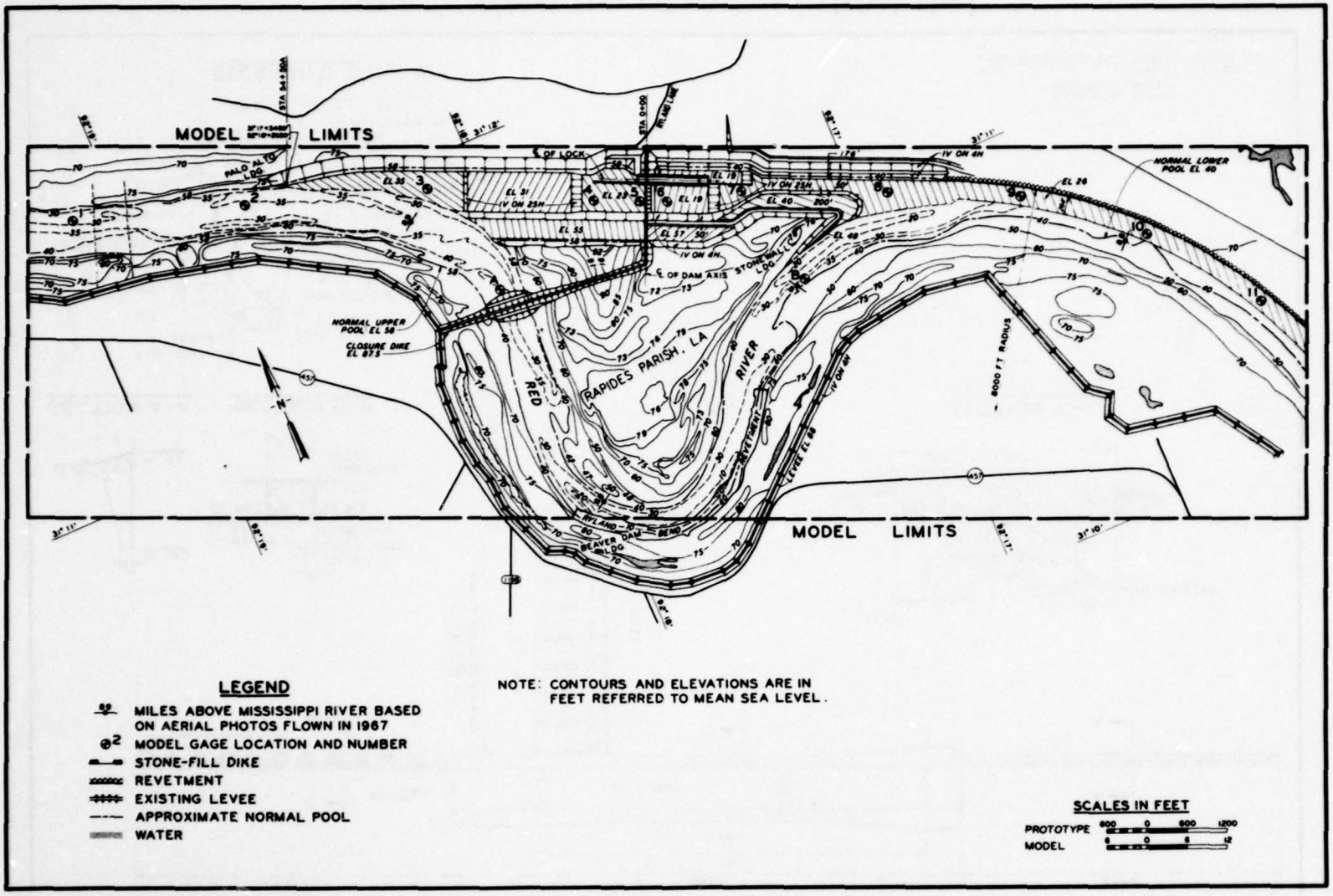


Figure 4. Original design

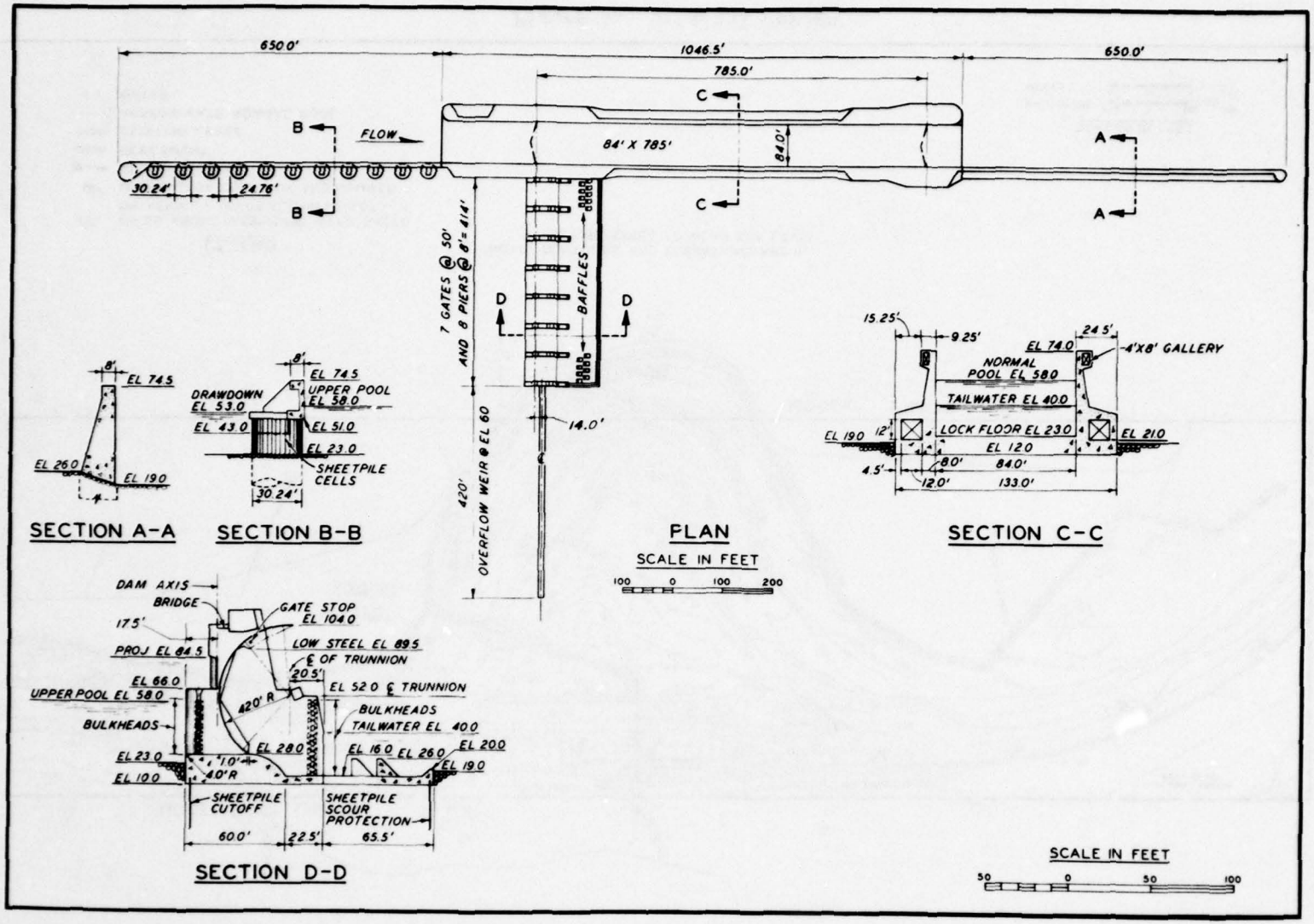


Figure 5. General plan and sections (original plan)

excavated to a bottom width of 264 ft at el 26.0, forming an 8,000-ft radius bend.

Results

18. Results shown in Table 1 indicate that the drop in water level across the dam (gages 5 and 6) ranged from about 0.4 ft with the maximum pool flow (78,000 cfs) to about 0.1 ft with the 110,000-cfs flow. The total drop from the end of the upper guard wall (gage 4) to the end of the lower guard wall (gage 7) ranged from about 1.4 ft with the 78,000-cfs flow to about 1.7 ft with the 110,000-cfs flow. With the higher discharge, there was considerable flow over the overflow weir section of the dam.

19. Distribution of flow through the gate bays of the spillway varied from 12 percent to 16.2 percent of the total with the 78,000-cfs flow (Table 2). Flow through the gate bays near the lock was affected by the alignment of the currents through the ports in the upper guard wall and through the gate bays on the right side by flow approaching the fixed weir and then angling toward the spillway.

20. Results shown in Plates 1-4 indicate the alignment of currents in the upper lock approach to be generally straight and parallel to the left bank line with all flows tested. Velocities in the upper approach channel varied from less than 2.0 fps to 2.3 fps with the 31,000-cfs flow and up to about 5.6 fps with the 78,000- and 145,000-cfs flows. Currents downstream of the dam moved toward the left bank across the lower approach just downstream of the lower guard wall but were generally parallel to the left bank farther downstream. With the original tailwater elevations, maximum velocities varied from about 8.6 fps with the 31,000-cfs flow to about 10.3 fps with the 78,000-cfs flow; these velocities were reduced with the revised tailwater elevations to about 6.3 and 8.2 cfs (Plates 5 and 6). There was no change in the tailwater elevation with the higher flows.

21. Navigation conditions for downbound tows approaching the lock would tend to be difficult and hazardous because of the effects of the currents on tows making the turn from the existing channel toward the left bank of the lock approach channel. Tows turning toward the left

bank would tend to have their sterns moved riverward unless sufficient power and steerage were maintained to overcome the effects of the currents moving toward the spillway (Photo 1a). If too much speed is maintained to offset the effects of the currents, the tow would be in danger of hitting the left bank. No serious difficulties were indicated for upbound tows leaving the lock (Photo 1b).

22. Upbound tows approaching the lock would be adversely affected by the limited maneuver area available in the lower lock approach and currents moving toward the left bank past the end of the lower guard wall. Because of the effects of the currents, tows with limited power would tend to be moved toward and against the left bank just downstream of the end of the guard wall (Photo 2a). Also, downbound tows leaving the lower lock approach tended to be moved toward the left bank, but no serious difficulties were indicated for tows maintaining adequate power (Photo 2b).

Plan A

Description

23. Plan A was designed to improve navigation conditions in the lock approaches and to modify the channel based on the results of the test of the original plan. This plan was the same as the original plan except for the following modifications (Figure 6):

a. Three rock dikes with top el 75.0 were placed along the right bank opposite the entrance to the excavated bypass canal. The dikes were 200 ft, 300 ft, and 500 ft long from upstream to downstream and were designed to improve the alignment of currents along the left bank of the approach channel and reduce the tendency for shoaling along that side.

b. The length of the overflow weir was reduced 45 ft to a length of 375 ft and the excavation along the right bank approaching the weir was reduced by moving the toe of the slope channelward 45 ft. The slope of the bank adjacent to the weir was placed at 15 percent and tied into the 1V-on-4H slope 300 ft upstream and downstream of the weir.

c. The lower guard wall was replaced with a floating guide wall along the land side of the lock.

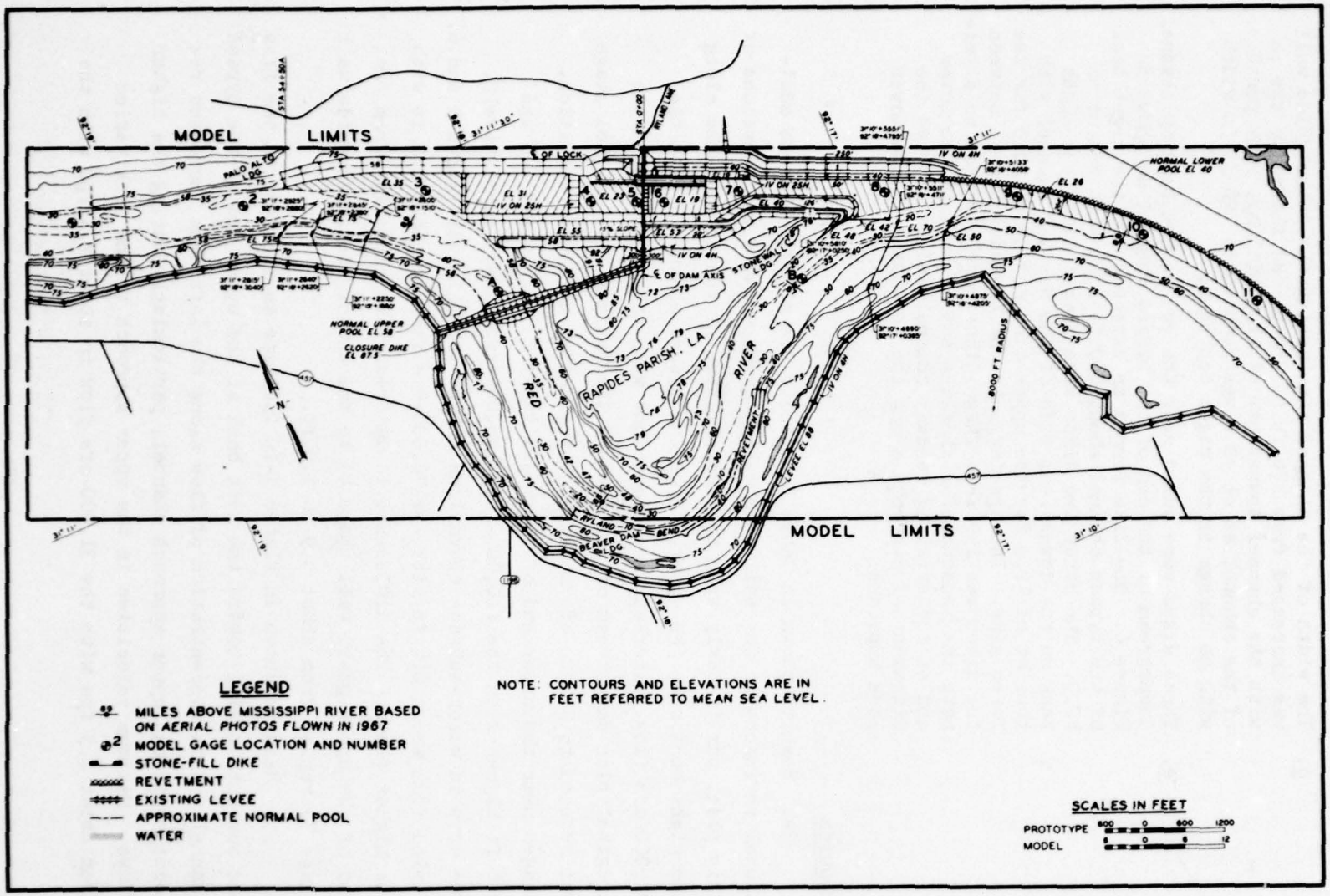


Figure 6. Plan A

d. The width of the channel approaching the lower guide wall was increased from 176 ft to 250 ft and flared to tie in with the channel downstream of the spillway. The portion of the channel at el 40.0 was reduced to 126 ft in width with no change in the right top bank.

e. Three dikes were added near the end of the bendway channel downstream of the end of the bypass channel as shown in Figure 6. One dike formed an extension of the right bank of the bypass channel about 800 ft long with top at el 42.0. The other two dikes were placed along the right bank on the downstream side of the bendway channel with tops at el 70.0 for the upper dike and at el 50.0 for the lower dike. The opening into the bendway channel between the dikes was 150 ft. These dikes were designed to eliminate the tendency for shoaling and closure of the lower end of the existing bendway channel and to improve the alignment of currents along the left bank in the lower lock approach.

Results

24. Results shown in Table 3 indicate the effects of some additional revisions in the tailwater rating curve and the modifications of this plan, particularly with the installation of the three dikes along the right bank near the upper end of the bypass channel. With the 31,000-cfs flow, water-surface elevations were higher than with the original plan downstream of the dam and the maximum flow at pool stage was reduced to 76,000 cfs because of the raised tailwater elevation. Stages near the upper end of the model (gage 1) were about 0.5 and 0.6 ft higher with the 110,000- and 145,000-cfs flows, respectively. The drop in water-surface elevations across the spillway (gages 5 and 6) varied from about 0.4 ft with the 76,000-cfs flow to about 0.2 ft with the higher flows. The difference in water-surface elevation from the end of the upper guard wall (gage 4) to the end of the lower guide wall (gage 7) varied from about 0.9 to 1.0 ft.

25. Results shown in Plates 7-10 indicate an increase in the flow and currents moving toward the left bank at the upper end of the bypass channel. This concentration of flow along the left bank increased velocities in the upper approach channel, particularly during the higher flows. Maximum velocities in the upper approach to the lock varied from about 2.5 fps with the 31,000-cfs flow to about 7.4 fps with the

145,000-cfs flow. There was some improvement in the alignment of the currents in the lower lock approach with some reduction in current velocities. Maximum velocities in the lower lock approach channel varied from about 5.6 fps with the 31,000-cfs flow to about 8.9 fps with the 145,000-cfs flow.

26. Navigation conditions in the upper approach were better than with the original design because of the improvement in the alignment of the currents near the upper end of the excavated left bank. However, downbound tows could experience some difficulty in maintaining proper alignment after making the turn toward the left bank because of the high-velocity currents and could be in danger of hitting the left bank. Navigation conditions in the lower lock approach were also better than with the original design but were affected by the high-velocity currents and currents that would tend to move an upbound tow toward the left bank just downstream of the end of the guide wall. There was a tendency for downbound tows to be moved toward the right bank near the lower end of the bypass channel.

Plan B

Description

27. Plan B involved modifications designed to reduce the amount of excavation and to improve the alignment of currents along the right bank just downstream of the lower end of the bypass channel. Accordingly, this plan was the same as plan A except for the following (Figure 7):

a. The length of the excavation along the right bank upstream and downstream of the overflow weir was reduced to 800 and 550 ft, respectively.

b. The dike forming an extension of the right bank at the lower end of the bypass channel was angled channelward by moving its lower end 100 ft to the left. The length of the first dike along the right bank downstream of the old bendway channel was extended 175 ft and the second dike was extended 200 ft.

Results

28. Water-surface elevations with plan B were generally higher

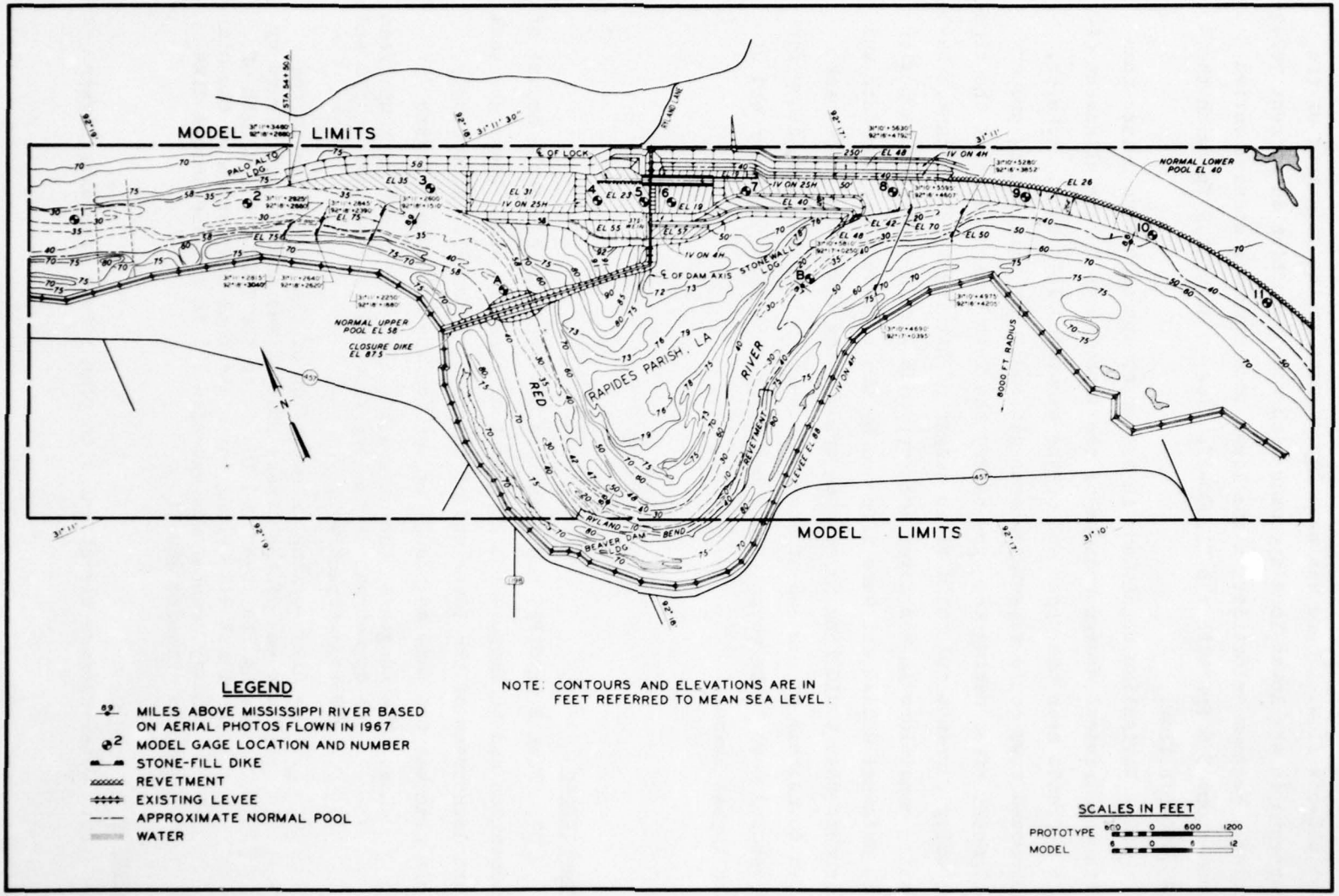


Figure 7. Plan B

than those with plan A upstream of the dam and for a short distance downstream (Table 4). Increases in water-surface elevations upstream of the dam ranged from about 0.2 to 0.5 ft with the open riverflows and from 0.3 to 0.4 ft just downstream of the dam. There was little change in the head across the dam but the total drop from the end of the upper guard wall to the end of the lower guide wall (gages 4-7) increased 0.2 ft ranging from a total of 1.1 to 1.2 ft.

29. There was little difference between plans A and B (Plates 11-14) in the alignment and velocity of currents in the upper lock approach. The velocity of currents in the lower lock approach with plan B was somewhat higher than that with plan A, but the alignment of the currents just downstream of the lower end of the bypass channel was better. Maximum velocities in the lower lock approach varied from about 5.1 fps with the 31,000-cfs flow to about 10.0 fps with the 145,000-cfs flow.

30. Navigation conditions in the upper approach to the lock were about the same as those with plan A. There was also little change in the tendency for upbound tows to be moved toward the left bank just downstream of the end of the lower guide wall. The tendency for tows to be moved toward the right bank below the lower end of the bypass channel was reduced, and upbound and downbound tows could pass in this reach without serious difficulties.

Plan C

Description

31. Plan C was the same as plan B except for the following modifications (Figure 8):

a. The length of the overflow weir was reduced to 330 ft and the right bank upstream and downstream of the weir was moved riverward 45 ft.

b. A 200-ft-long wing dike with crest at el 40.0 was placed at the lower end of the riverward lock wall and angled 10 deg riverward of the wall.

c. The transition of the right bank downstream of the dam was moved downstream to provide a 300-ft-wide channel at el 26.0 between the end of the wing dike and the toe of the

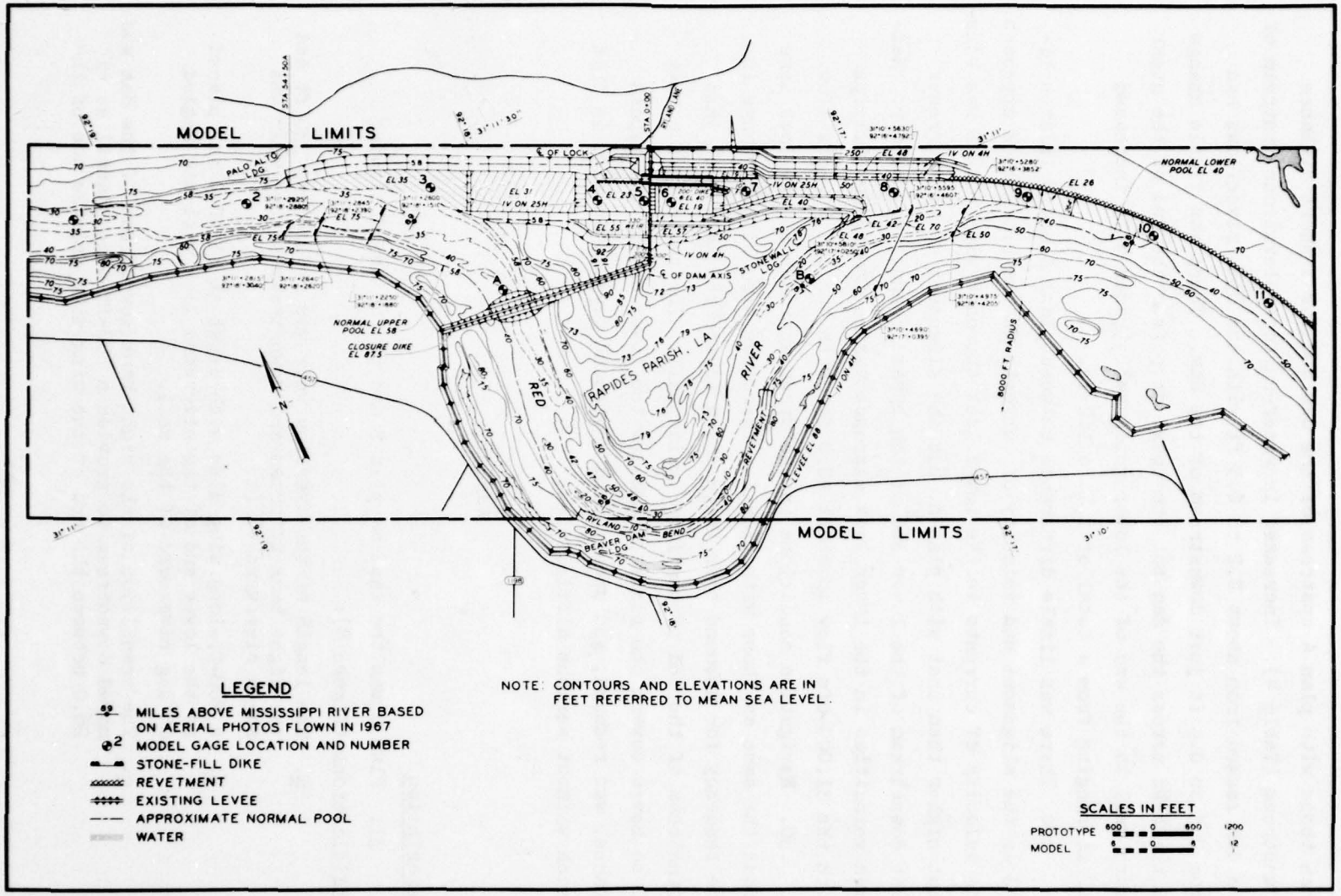


Figure 8. Plan C

right bank slope. The toe of the right bank slope downstream of the latitude of the end of the wing dike was made straight for a distance of about 700 ft to provide a more gradual transition toward the lower reach of the bypass channel.

Test of plan C was conducted with tailwater elevations based on a revised rating curve furnished by the LMN office.

Results

32. Results shown in Table 5 indicate considerable differences in water-surface elevations from those obtained with plan B, caused mostly by the increase in tailwater elevations in accordance with the revised rating curve. These results indicate little difference in the head across the dam but a considerable reduction in the difference in the water-surface elevations between the end of the upper guard wall (gage 4) and the end of the lower guard wall (gage 7) which ranged from 0.6 to 0.7 ft. Also, because of the higher tailwater elevation, the maximum flow at which the normal upper pool elevation could be maintained was reduced to 58,000 cfs.

33. Modification of the tailwater elevation had little effect on current directions and velocities upstream of the dam except for the maximum flow at normal pool elevation caused by the reduction in discharge. The maximum velocity in the upper approach to the lock with the 58,000-cfs flow varied from about 4.8 to about 5.6 fps and in the lower approach from about 5.7 to 6.4 fps (Plate 15). Velocities in the reach downstream of the dam were reduced appreciably with the 31,000- and the 145,000-cfs flows from those obtained with plan B (Plate 16). Maximum velocities in the lower lock approach with these flows were about 4.4 and 8.2 fps, respectively.

34. Navigation conditions in the upper lock approach were not affected appreciably by the modifications of plan C and no serious difficulties were indicated. Conditions in the lower lock approach were improved considerably by the reduction in current velocities and the effects of the wing dike which reduced the tendency for tows to be moved toward the left bank downstream of the end of the guide wall. Navigation conditions with the improvements of plan C were considered satisfactory.

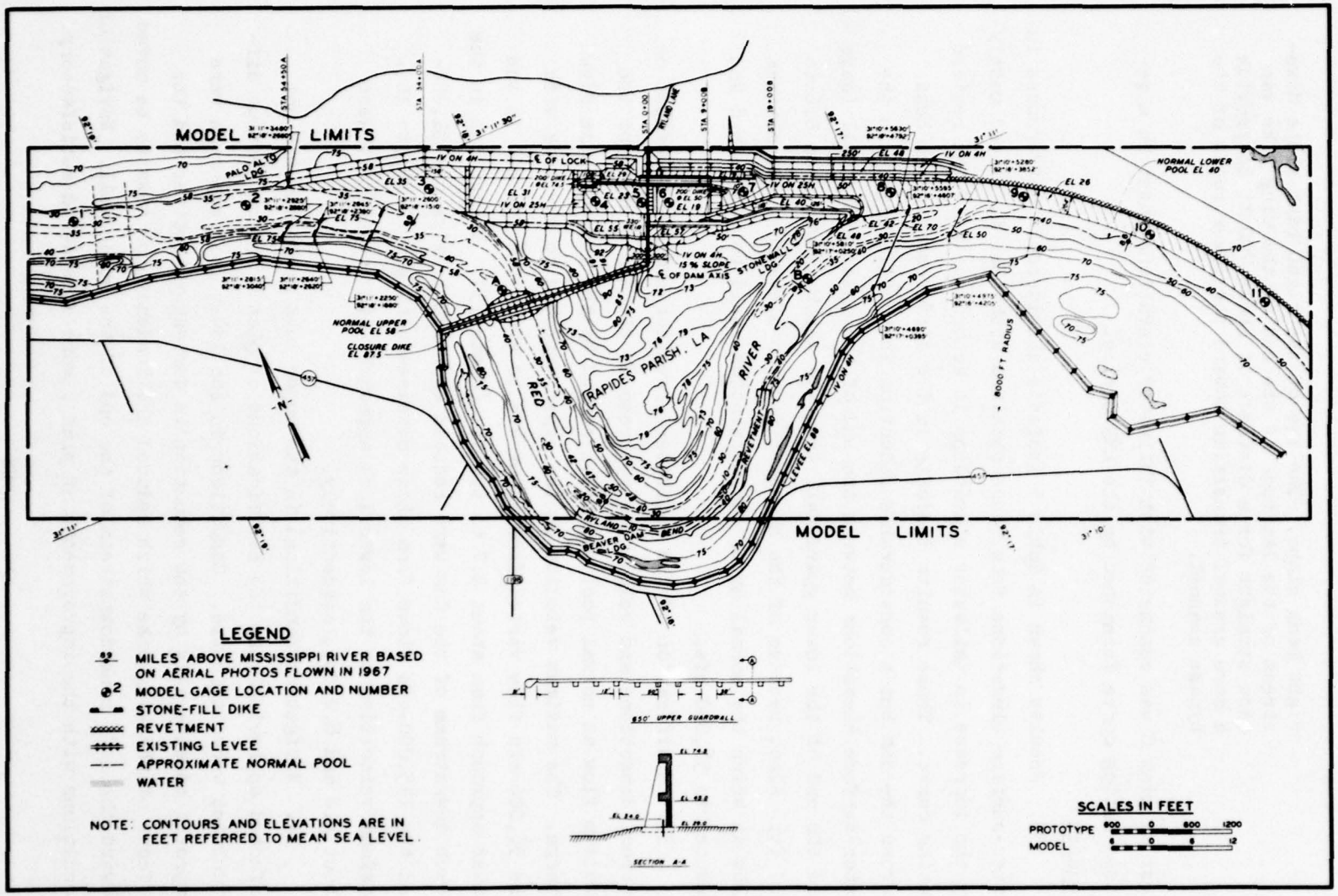


Figure 9. Plan D

Plan D

Description

35. Plan D was designed to improve navigation conditions in the upper lock approach, particularly for downbound tows with limited power. This plan was the same as plan C except for the following (Figure 9):

a. The toe of the slope of the left bank approaching the lock was moved landward to 108 ft from the lock center line near the end of the upper guard wall and 158 ft from the lock center line at sta 34+00. From that point the left bank was angled riverward on a straight line, intersecting the left bank of the existing channel at sta 54+50.

b. The lock upper guard wall was replaced with a 650-ft-long buttress-type wall having twelve 38-ft-wide ports with a 25-ft-wide port next to the lock. The tops and bottoms of the ports were at el 45.0 and 34.0, respectively. The bottom of the lock approach channel on the lock side of the guard wall was at el 29.0.

c. A 200-ft-long rock dike with crest el 74.5 was placed as an extension to the upper guard wall. The toe of the slope of the lock side of the dike was placed in line with the lock side of the guard wall.

d. The wing dike of plan C at the lower end of the river-side lock wall was raised to el 50.0.

Results

36. Results shown in Table 6 indicate little change in water-surface elevations from those obtained with plan C. The drops in water-surface elevation across the dam (gages 5 and 6) were only about 0.1 to 0.2 ft and the total drop from the end of the upper guard wall (gage 4) to the end of the lower guide wall (gage 7) varied from about 0.5 ft with the 58,000-cfs flow to 0.8 ft with the higher flows.

37. There was a general improvement in the alignment of currents along the left bank approaching the lock except for the outdraft near the upper end of the rock dike forming an extension to the upper guard wall and the effects of the eddy between the guard wall and left bank (Plates 17-20). There was also some improvement in the alignment of currents in the lower lock approach but velocities continued to be rather high. Maximum velocities with the 31,000- and 145,000-cfs flows

varied from about 2.2 fps to 8.2 fps in the upper approach and from about 5.0 fps to 9.3 fps in the lower lock approach.

38. Navigation conditions in the upper lock approach for downbound tows were generally good except for the effects of the outdraft near the end of the rock dike at the end of the guard wall and the eddy on the lock side of the guard wall which tended to move the head of tows approaching the lock away from the wall. No difficulties were indicated for downbound tows making the turn from the existing channel toward the left bank at the upper end of the bypass channel. Tows with sufficient power to overcome the effects of the high-velocity currents in the lower approach should experience no difficulties in approaching or leaving the lock (Photos 3 and 4). Two-way traffic could be maintained downstream of the lower guide wall since tows could approach or leave the guide wall from either side of the channel. Conditions would be generally better with downbound tows proceeding along the left side of the channel and upbound tows along the right side, since less maneuvering would be required.

Plan D-Modified

Description

39. Plan D-modified was concerned principally with the outdraft near the end of the upper guard wall and the effects of the eddy between the guard wall and left bank. This plan was the same as plan D except for the following (Figure 10):

a. The length of the upper guard wall was increased to 750 ft and the number of ports in the wall increased to 15. The ports were 38 ft wide except for the one near the lock which was 25 ft with bottom elevations at 29.0; tops of the first seven ports on the upstream end were at el 45.0 and the remainder at el 49.0.

b. The amount of excavation along the right bank was reduced to a maximum of 1,200 ft upstream of the overflow weir and 900 ft downstream.

Results

40. The modifications of plan D-modified had little or no effect

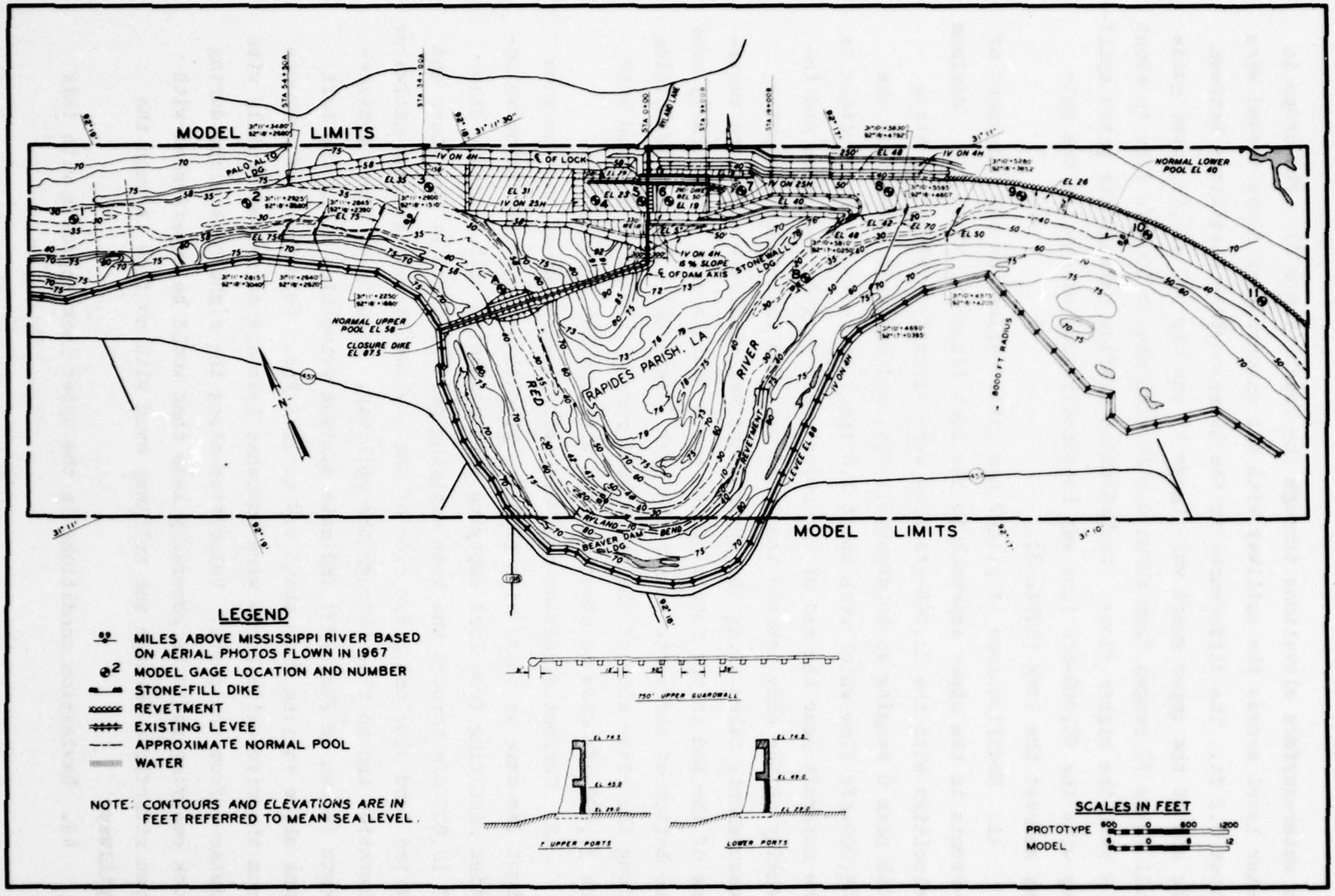


Figure 10. Plan D-modified

on water-surface elevations through the reach (Table 7). The drops in water level across the spillway with all uncontrolled flows tested were about 0.2 ft. The differences in the water-surface elevations between the end of the upper guard wall (gage 4) and the end of the lower guide wall (gage 7) ranged from about 0.6 ft with the 58,000-cfs flow to about 0.9 with the higher flows. Distribution of flow through the gated spillway with the 58,000-cfs flow was reasonably good except for the gate bay nearest the lock (Table 8).

41. Modifications of plan D had little effect on the alignment of currents in the upper approach to the lock (Photo 5, Plate 21). Maximum velocities with the 31,000-cfs flow were slightly higher than those with plan D ranging up to about 2.7 fps, and somewhat lower with the 145,000-cfs flow which were about 7.8 fps. There was some reduction in the outdraft near the end of the upper guard wall but the size and intensity of the eddy between the guard wall had increased. Velocity measurements taken along the upper guard wall indicate that some scouring of the bed at the bottom of the ports could occur, particularly near the bottom of the ports nearer the lock (Plate 22). Maximum velocities along the river side of the guard wall ranged from about 6.2 fps with the 31,000-cfs flow to about 8.3 fps with the 145,000-cfs flow.

42. Current direction and velocities downstream of the dam were about the same as those with plan D. Special tests to determine velocities resulting from lock emptying were conducted with a steady flow of 10,000 cfs through the lock emptying ports located at the lower end of the land side and river side of the lock walls with minimum tailwater elevation and no flow through the spillway. Results of these measurements (shown in Plate 23) indicate maximum velocities along the left bank slope varying from about 6.8 to 11.1 fps. Velocities of currents from the river-side ports were somewhat less and decreased rapidly with distance from the ports. Velocities along the right bank slope during lock emptying would be generally less than would be experienced with open riverflows through the spillway even with no flow through the spillway.

43. Navigation conditions in the upper lock approach with this

plan were considerably better than those with plan D. Because of the reduction in the outdraft near the end of the upper guard wall, downbound tows properly aligned for the approach could drift toward the lock and approach the guard wall from a considerable distance upstream (Photo 6). The eddy landward of the guard wall would have a tendency to move the head of the tow away from the guard wall near the lock but the effect would be small. Upbound tows should have little or no difficulty in moving away from the guard wall (Photo 7). Two-way traffic could be maintained upstream of the end of the guard wall under most conditions. However, there would be greater efficiency and less chance for interference between tows with downbound tows approaching the lock from along the left bank and upbound tows moving riverward after clearing the end of the guard wall (Photo 8).

Plan E

Description

44. Plan E involved the replacement of the lower guide wall with a guard wall on the river side of the lock approach. This plan was the same as plan D-modified except for the following (Figure 11):

a. The floating guide wall in the lower lock approach was replaced with a 650-ft-long solid buttress-type guard wall on the river side of the lock.

b. The left bank between sta 15+60B and 23+60B was excavated along a straight line to provide additional maneuver area for tows approaching and leaving the lock.

c. The right bank was shifted to the right to provide a width of 300 ft between the end of the lower guard wall and toe of the slope of the right bank.

Results

45. Water-surface elevations shown in Table 9 indicate no change in the reach upstream of the dam from those obtained with plan D-modified. Some lowering of the water-surface elevation was noted downstream of the dam, particularly near the end of the guard wall. This difference amounted to about 0.1 ft with the lower flows to about 0.3 ft with the 145,000-cfs flow. The differences in water level across the

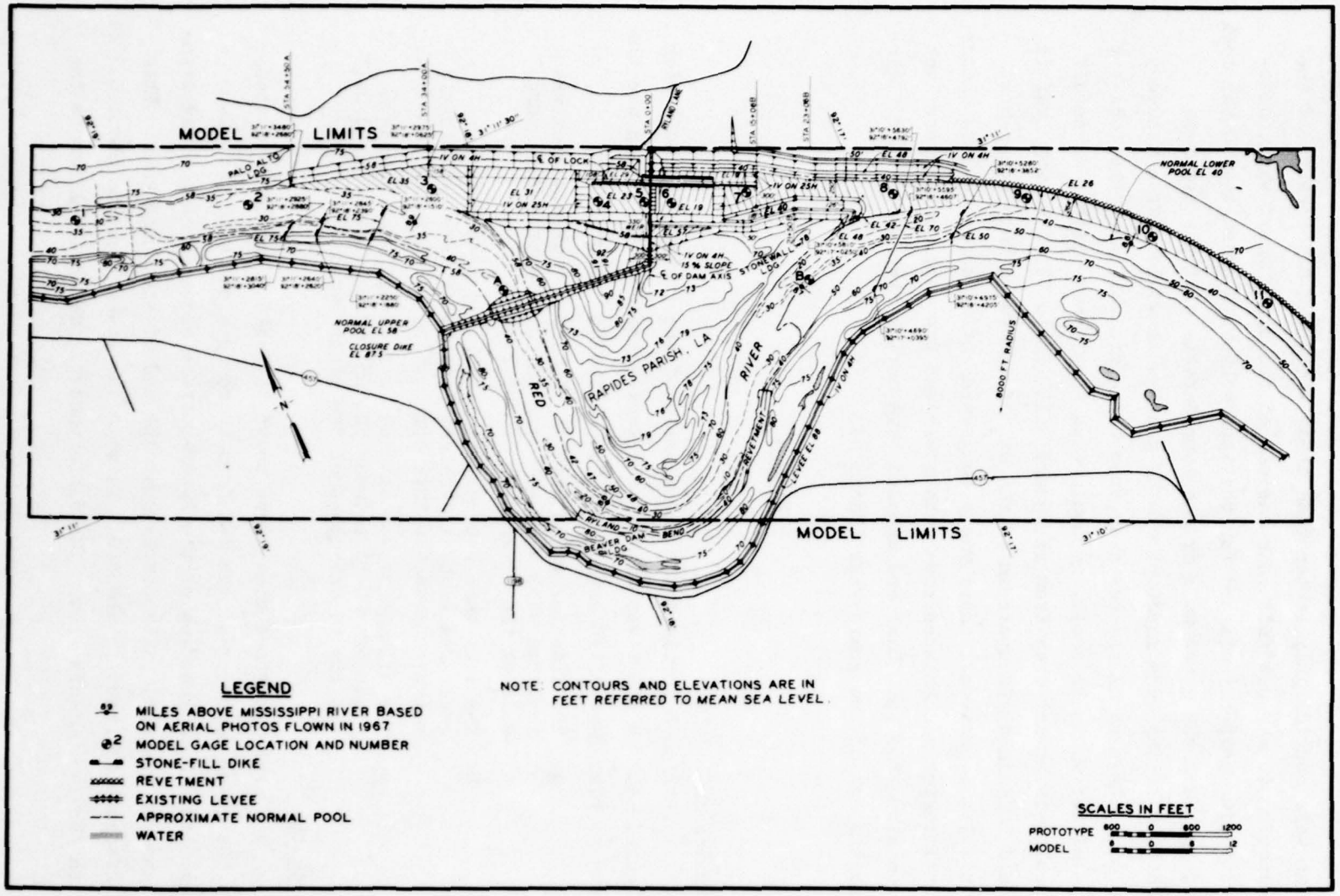


Figure 11. Plan E

spillway (gages 5 and 6) varied from about 0.2 to 0.3 ft, and from the end of the upper guard wall to the end of the lower guard wall (gages 4-7) from about 0.7 to 1.2 ft. The latter difference obtained with the 145,000-cfs flow was effected by the lowering of the water-surface elevation at the end of the lower guard wall (gage 7) of 0.3 ft.

46. The changes downstream of the dam had no effect on current directions and velocities upstream of the dam. Results shown in Plate 24 and Photo 9 indicate little difference in the alignment of currents in the lower lock approach from those obtained with the floating guide wall. Maximum velocities in the lower lock approach (along the left bank) were about the same as those with plan D with the lower flows and somewhat less with the higher flows. There was a tendency for a counterclockwise eddy to form between the lower guard wall and the left bank with all flows. The size and intensity of the eddy increased with increase in discharge.

47. No serious difficulties were indicated for navigation approaching or leaving the lock. However, because of the limited maneuver area and the alignment of the currents downstream of the end of the guard wall, upbound tows could not approach the guard wall and become aligned along the wall without some maneuvering. Also, downbound tows leaving the lock wall would have to maintain power and steerage to offset the effects of the currents that would tend to move the tow toward and against the left bank (Plates 10 and 11). Two-way traffic could be maintained downstream of the end of the lower guard wall but conditions would be safer with downbound tows moving downstream along the left bank and upbound tows approaching from along the right side. More time and maneuvering would be required for upbound tows approaching the lock from the right than from the left side.

PART IV: DISCUSSION OF RESULTS AND CONCLUSIONS

Limitation of Model Results

48. In the analysis and evaluation of the results of this investigation, it should be considered that the model was of the semifixed-bed type designed to provide some general information on navigation conditions that could be expected with various arrangements of the lock and dam, modifications in the excavated channel, and training structures that might be required. The conclusions reached are based principally on a study of water-surface elevations, current directions and velocities, and effects of the resulting currents on the model towboat and tow with the conditions imposed on the model with each plan. The Red River is an alluvial stream and its channel configurations will be affected by the movement of sediment which is constantly changing with changes in the operation of the spillway and flow conditions.

49. The movement of sediment in the reach reproduced in the model can affect channel width and depth, water-surface slopes, and the alignment and velocity of currents. A movable-bed model study has been undertaken to determine the adequacy of the proposed design in maintaining an adequate channel through the reach and it is probable that additional training structures and modifications will be indicated, particularly in the reach downstream of the dam. Since these modifications and changes in the bed configurations will affect water-surface elevations and current direction and velocities, the results presented herein should be used as indications for comparative purposes only.

50. In spite of the limitations mentioned, the model study was sufficient to provide the information needed in the design and arrangement of the basic features of the lock and dam and the navigation conditions that could be expected. The model was also used to provide the plans to be considered for study in the movable-bed model.

Summary of Results and Conclusions

51. The results of the investigation and the conclusions indicated were as follows:

a. Current velocities in the lock approaches with open river-flows would tend to be high, particularly in the lower approach. Velocities will be affected by scouring and deposition within the channel and changes in the tailwater elevations.

b. Navigation conditions in the upper lock approach would tend to be difficult and hazardous with the original plan because of the alignment of the currents and the need for downbound tows to turn toward the left bank.

c. Dikes will be required along the right bank upstream of the old bendway channel to improve the alignment of the currents toward the approach channel and to reduce the tendency for shoaling along the left bank of the approach channel.

d. Length of the overflow weir and excavation along the right bank upstream and downstream of the weir could be reduced without any adverse effect on navigation conditions in the upper lock approach or flow through the dam.

e. Satisfactory navigation conditions could be developed in the upper lock approach with some additional excavation and modification of the left bank of the approach channel and an increase in the length of the upper guard wall as shown in plan E.

f. Navigation conditions in the lower lock approach with the original design would tend to be difficult because of the limited maneuver area available landward of the guard wall and the effects of the currents moving toward the left bank downstream of the end of the wall.

g. Satisfactory navigation conditions in the lower lock approach could be developed with either a floating guide wall (land side of lock) or a guard wall (river side of lock). With a guide wall, a wing dike would be required at the lower end of the river-side lock wall to improve the alignment of currents and reduce the tendency for shoaling in the lock approach (plan D). Use of a lower guard wall would require modification of the left bank landward and downstream of the guard wall to provide additional maneuver area (plan E). Navigation conditions for two-way traffic would tend to be better with the guide wall than with the guard wall.

h. Dikes would be required along the right bank at the lower end of the bypass channel and downstream of the end of the old bendway channel to improve the alignment of currents in the vicinity and reduce the tendency for shoaling of the entrance into the old channel.

i. Velocities during lock emptying will tend to be high along the left bank with emptying ports on the land side of the landward lock wall.

j. Distribution of flow through the gated spillway would be reasonably uniform except for the gate bay nearest the lock.

k. The difference in water-surface elevation across the dam will tend to be small with all open riverflows tested.

Table 1

Water-Surface Elevations, Original Design

Gage No.	Water-Surface Elevations, ft msl					
	Q, cfs 31,000	Q, cfs 78,000	Q, cfs 31,000	Q, cfs 78,000	Q, cfs 110,000	Q, cfs 145,000
1	58.4	59.5	58.4	60.7	66.3	72.9
2	58.3	58.8	58.3	60.2	65.7	72.5
3	58.2	58.5	58.2	60.6	65.6	72.4
4	58.0*	58.0	58.0*	59.4	65.1	72.0
5	58.0	57.6	58.0	59.2	64.7	71.7
6	46.0*	57.3*	49.8	58.8	64.6*	71.5*
7	45.2	56.4	49.3	58.0	63.4	70.4
8	44.1	56.0	49.0	57.8	63.2	70.2
9	43.7	55.7	48.9	57.6	63.1	70.1
10	42.2	54.7	48.4**	56.8**	62.4	69.6
11	40.8	53.8	48.0	56.3	61.9	69.3
A	58.1	58.7	58.2	60.0	65.7	72.4
B	44.1	56.0	49.0	57.8	63.3	70.2

* Controlled elevations, based on normal upper pool and computed tailwater rating curve shown in DM No. 18 dated May 1977.

** Controlled elevations, based on a revised rating curve furnished on 17 May 1977.

Table 2

Original Design, Flow Distribution

Through Gated Spillway in

Percent of Total

Gate Bay No.*	Discharge 78,000 cfs**
1	12.6
2	13.3
3	15.8
4	16.2
5	15.2
6	14.9
7	12.0

* Gate bays numbered from left to right.

** Maximum pool flow with low tail water.

Table 3

Water-Surface Elevations, Plan A

Gage No.	Water-Surface Elevations, ft msl			
	Q, cfs 31,000	Q, cfs 76,000	Q, cfs 110,000	Q, cfs 145,000
1	58.4	60.1	66.8	73.5
2	58.3	59.5	66.3	73.0
3	58.1	58.3	65.3	72.2
4	58.0*	58.0	65.2	72.0
5	58.0	57.7	64.8	71.7
6	49.0*	57.3*	64.6*	71.5*
7	48.9	57.1	64.2	71.1
8	48.5	56.6	63.9	70.9
9	48.3	56.3	63.7	70.8
10	47.8	55.4	63.1	70.3
11	47.4	54.7	62.5	69.9
A	58.1	58.3	65.4	72.2
B	48.5	56.6	63.9	70.9

* Controlled elevations, based on revised tailwater rating curve dated 26 May 1977.

Table 4

Water-Surface Elevations, Plan B

Gage No.	Water-Surface Elevations, ft msl			
	Q, cfs 31,000	Q, cfs 76,000	Q, cfs 110,000	Q, cfs 145,000
1	58.4	60.3	67.3	73.9
2	58.3	59.8	66.8	73.5
3	58.1	58.7	65.8	72.6
4	58.0*	58.3	65.5	72.3
5	57.9	58.0	65.2	72.0
6	49.1	57.7	65.0	71.8
7	48.8	57.1	64.3	71.2
8	48.5	56.7	64.0	71.0
9	48.3	56.3	63.7	70.8
10	47.8	55.5	63.1	70.3
11	47.4*	54.7*	62.5*	69.9*
A	58.1	58.7	65.8	72.6
B	48.5	56.7	64.2	71.0

* Controlled elevations.

Table 5

Water-Surface Elevations, Plan C

Gage No.	Water-Surface Elevations, ft msl		
	Q, cfs 31,000	Q, cfs 58,000	Q, cfs 145,000
1	58.4	59.3	74.2
2	58.3	58.9	73.8
3	58.1	58.2	72.9
4	58.0*	58.0	72.5
5	58.0	57.8	72.3
6	51.2	57.6	72.0
7	51.1	57.4	71.8
8	50.8	57.2	71.4
9	50.6	56.9	71.1
10	50.3*	56.5*	70.6*
11	50.1	56.2	70.3
A	58.1	58.2	72.9
B	50.8	57.2	71.4

* Controlled elevations, based on revised tailwater rating curve received 1 July 1977.

Table 6

Water-Surface Elevations, Plan D

Gage No.	Water-Surface Elevations, ft msl			
	Q, cfs 31,000	Q, cfs 58,000	Q, cfs 110,000	Q, cfs 145,000
1	58.4	59.3	69.3	74.2
2	58.3	58.9	68.9	73.7
3	58.2	58.2	68.1	72.9
4	58.0*	57.9	67.6	72.4
5	58.0	57.7	67.4	72.2
6	51.2	57.6	67.2	72.0
7	51.0	57.4	66.8	71.6
8	50.8	57.1	66.5	71.3
9	50.6	56.9	66.3	71.0
10	50.3	56.4	65.8**	70.6
11	50.1*	56.2*	65.5	70.3*
A	58.2	58.2	68.1	72.9
B	50.8	57.1	66.6	71.3

* Controlled elevations.

** Controlled elevation, based on revised tailwater rating curve received 1 July 1977.

Table 7

Water-Surface Elevations, Plan D-Modified

Gage No.	Water-Surface Elevations, ft msl			
	Q, cfs 31,000	Q, cfs 58,000	Q, cfs 110,000	Q, cfs 145,000
1	58.4	59.3	69.3	74.2
2	58.3	58.9	68.9	73.7
3	58.2	58.2	68.0	72.9
4	58.0*	58.0	67.7	72.5
5	58.0	57.8	67.4	72.2
6	51.2	57.6	67.2	72.0
7	51.0	57.4	66.8	71.6
8	50.8	57.1	66.5	71.3
9	50.6	56.9	66.3	71.0
10	50.3	56.4	65.9	70.6
11	50.1*	56.2*	65.5*	70.3*
A	58.2	58.2	68.0	72.9
B	50.9	57.1	66.6	71.3

* Controlled elevations.

Table 8

Plan D-Modified, Flow Distribution

Through Gated Spillway in

Percent of Total

Gate Bay No.*	Discharge 58,000 cfs **
1	10.7
2	13.6
3	15.3
4	15.9
5	15.7
6	15.4
7	13.4

* Gate bays numbered from left to right.

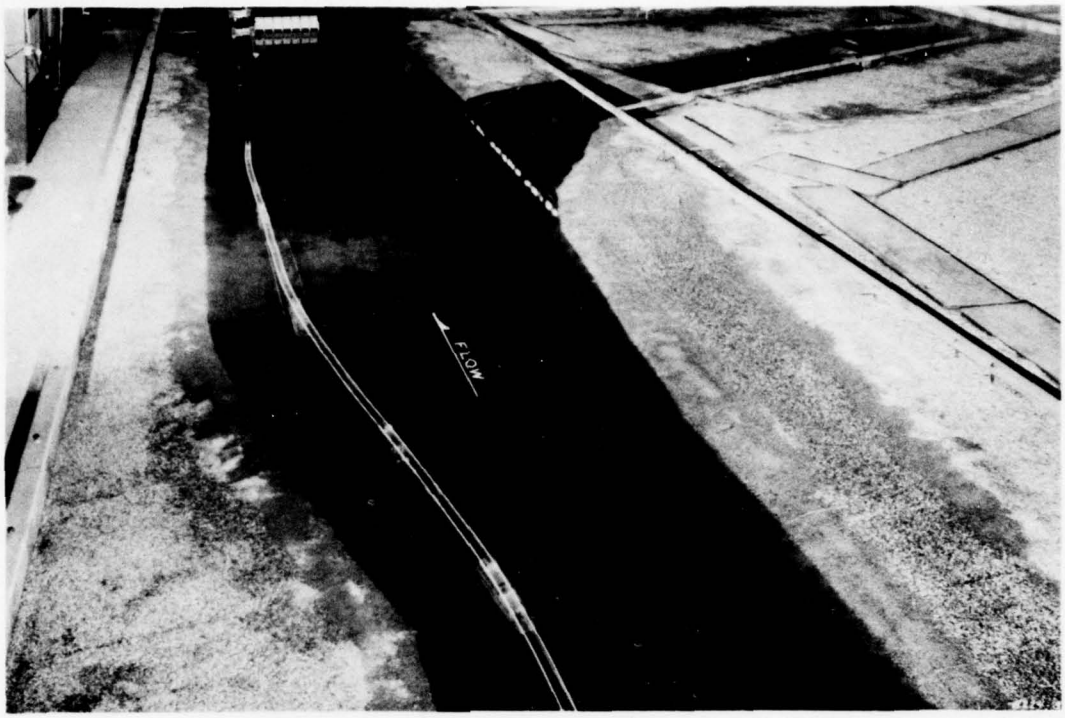
** Maximum pool flow.

Table 9

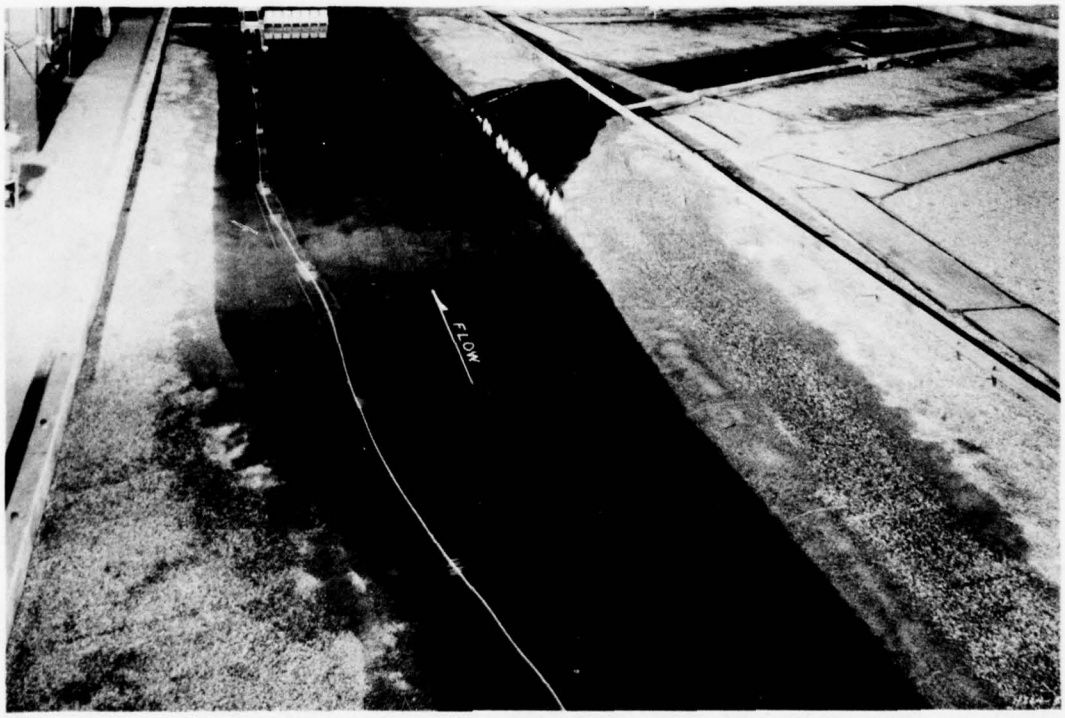
Water-Surface Elevations, Plan E

Gage No.	Water-Surface Elevations, ft msl			
	Q, cfs 31,000	Q, cfs 58,000	Q, cfs 110,000	Q, cfs 145,000
1	58.4	59.3	69.3	74.2
2	58.3	58.9	68.9	73.7
3	58.2	58.2	68.0	72.9
4	58.0*	58.0	67.7	72.5
5	58.0	57.7	67.4	72.2
6	51.1	57.5	67.1	72.0
7	51.0	57.3	66.6	71.3
8	50.8	57.1	66.5	71.2
9	50.6	56.9	66.3	71.0
10	50.3	56.4	65.9	70.6
11	50.1*	56.2*	65.5*	70.3*
A	58.2	58.2	68.0	72.9
B	50.9	57.1	66.5	71.3

* Controlled elevations.

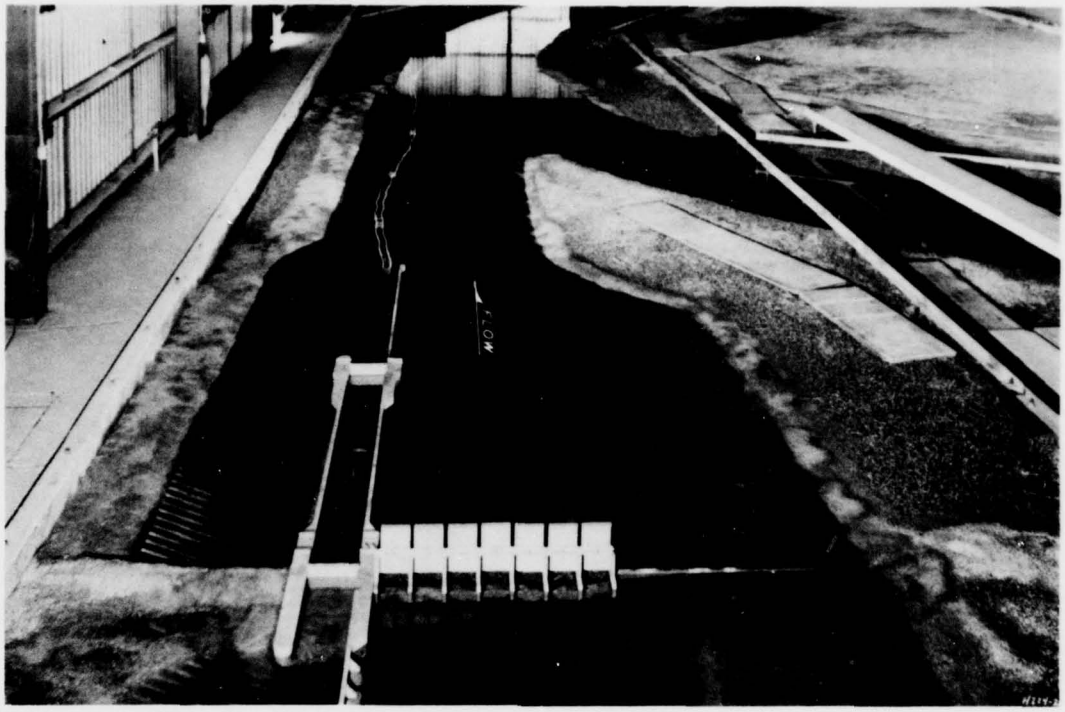


a. Path of downbound tow approaching lock

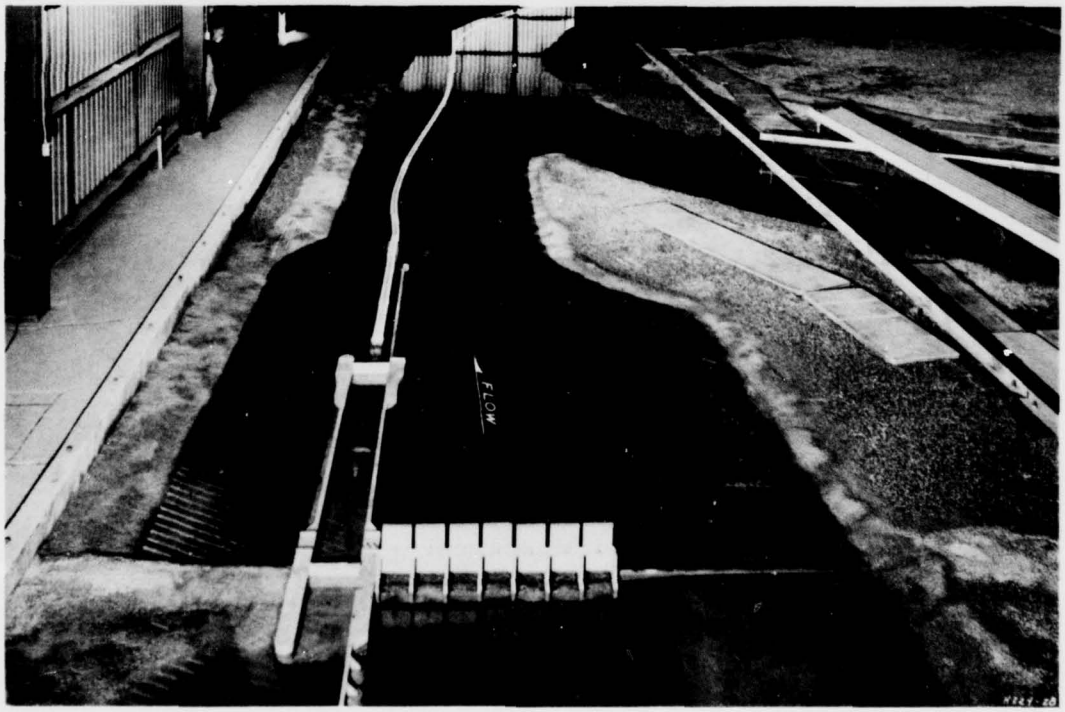


b. Path of upbound tow leaving lock

Photo 1. Original plan; discharge 78,000 cfs, upper pool el 58.0

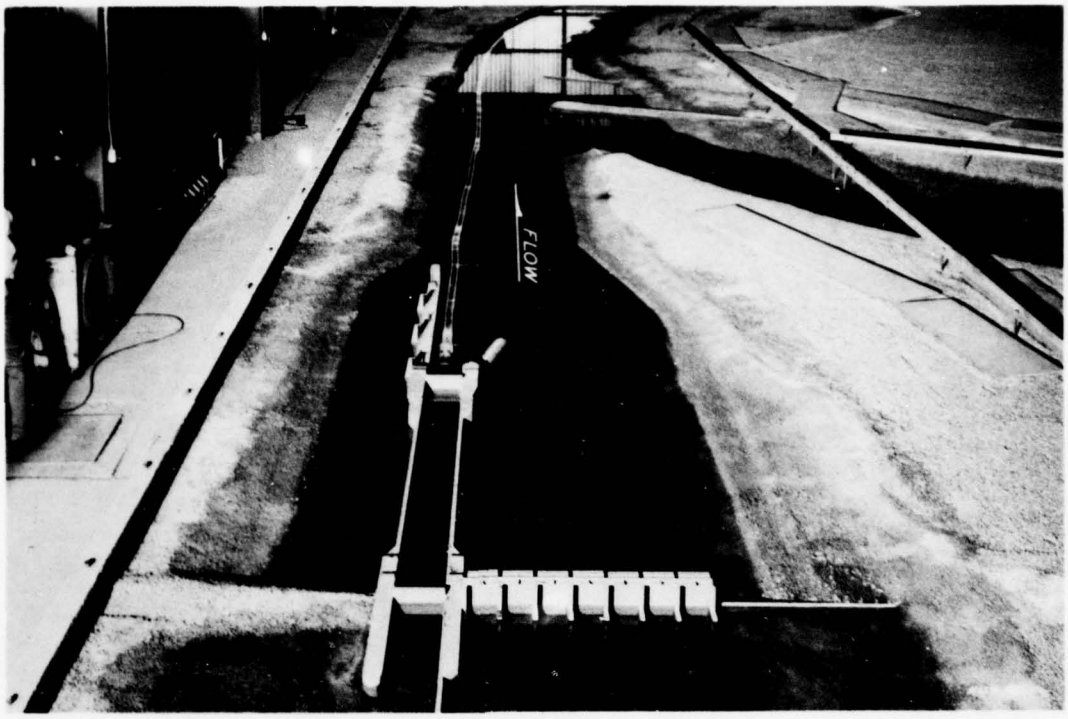


a. Path of upbound tow approaching lock. Note maneuvering required to offset effects of currents moving toward left bank

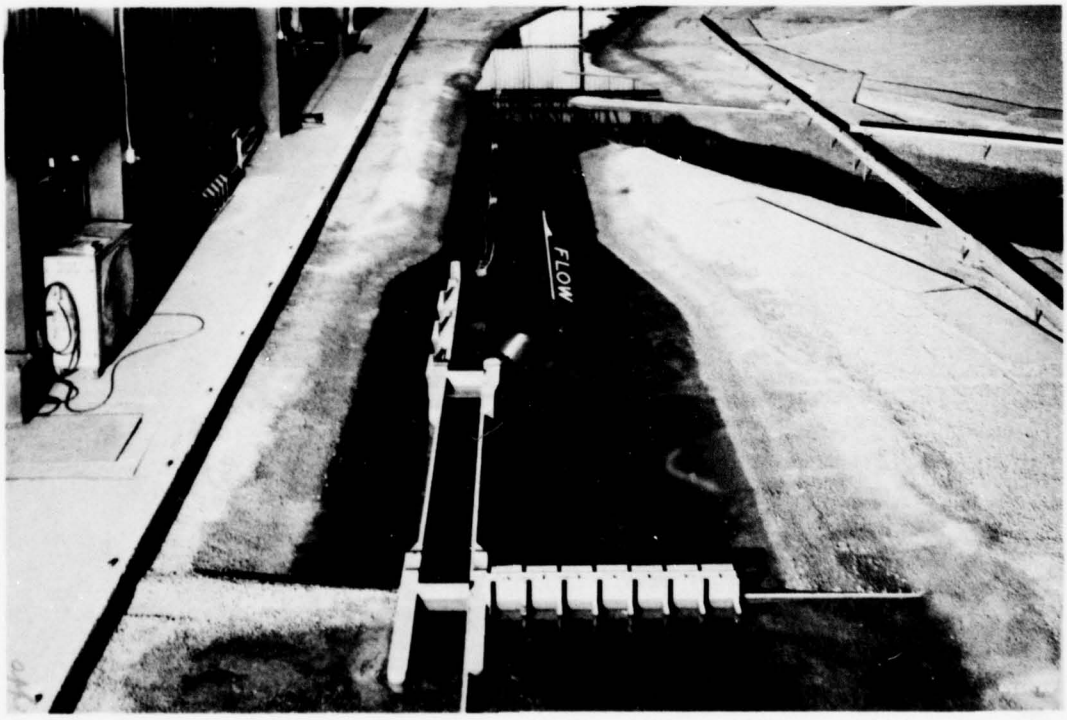


b. Path of downbound tow leaving lock. Note tendency for tow to be moved toward left bank downstream of the end of guard wall

Photo 2. Original plan; discharge 78,000 cfs, lower pool el 57.3

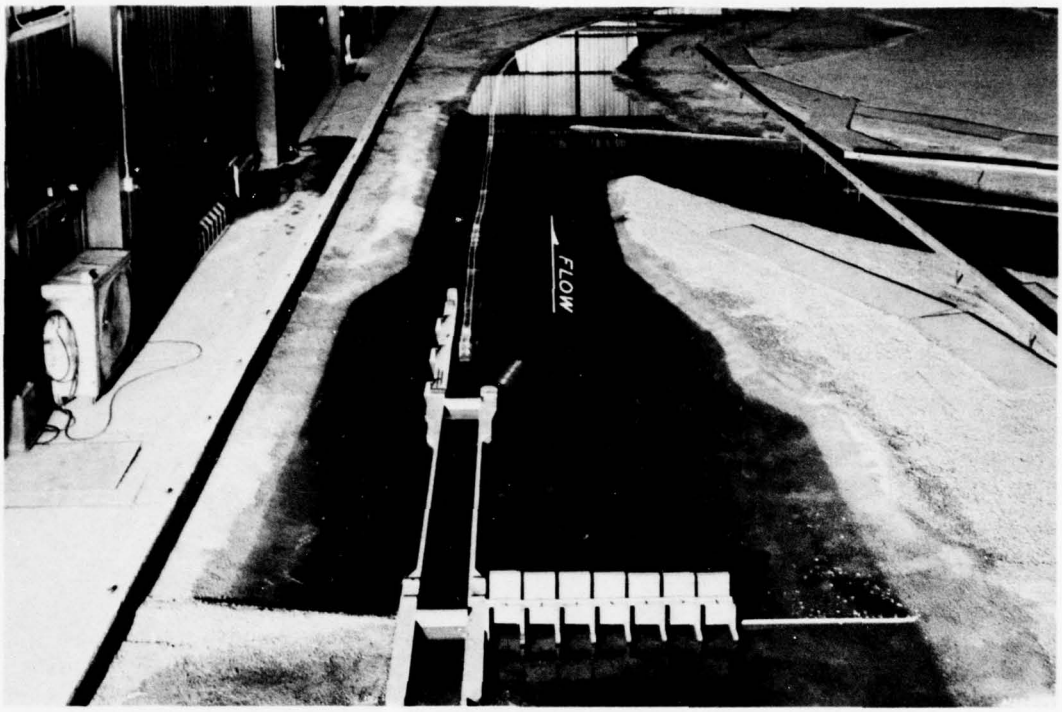


a. Path of downbound tow leaving lock

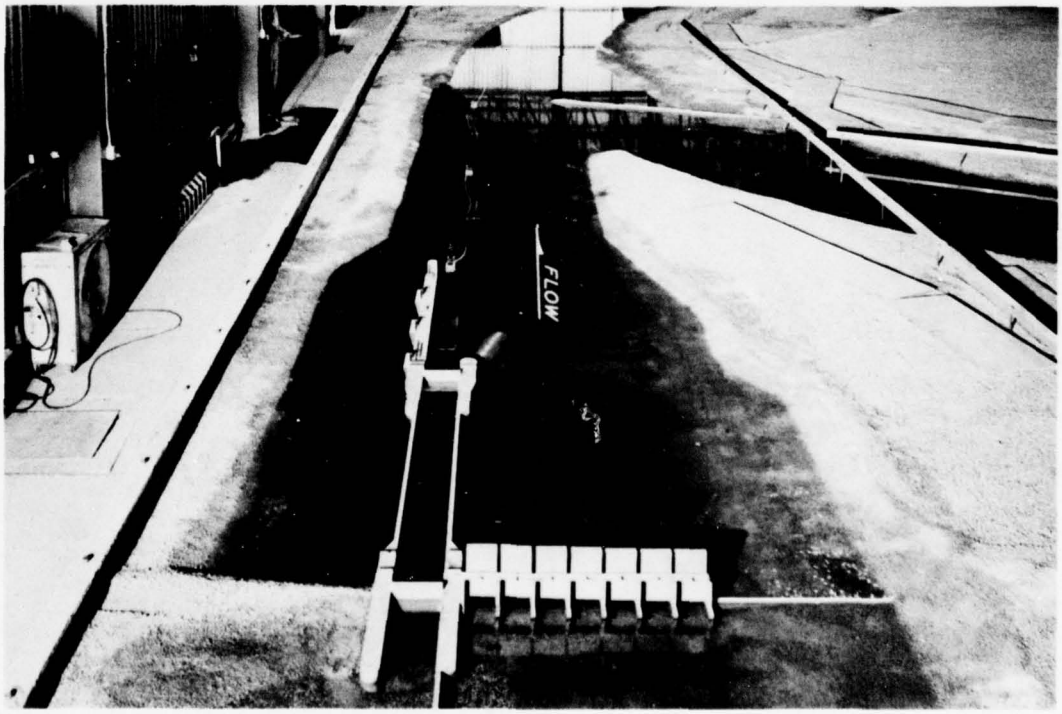


b. Path of upbound tow approaching lock

Photo 3. Plan D; discharge 31,000 cfs, lower pool el 50.0



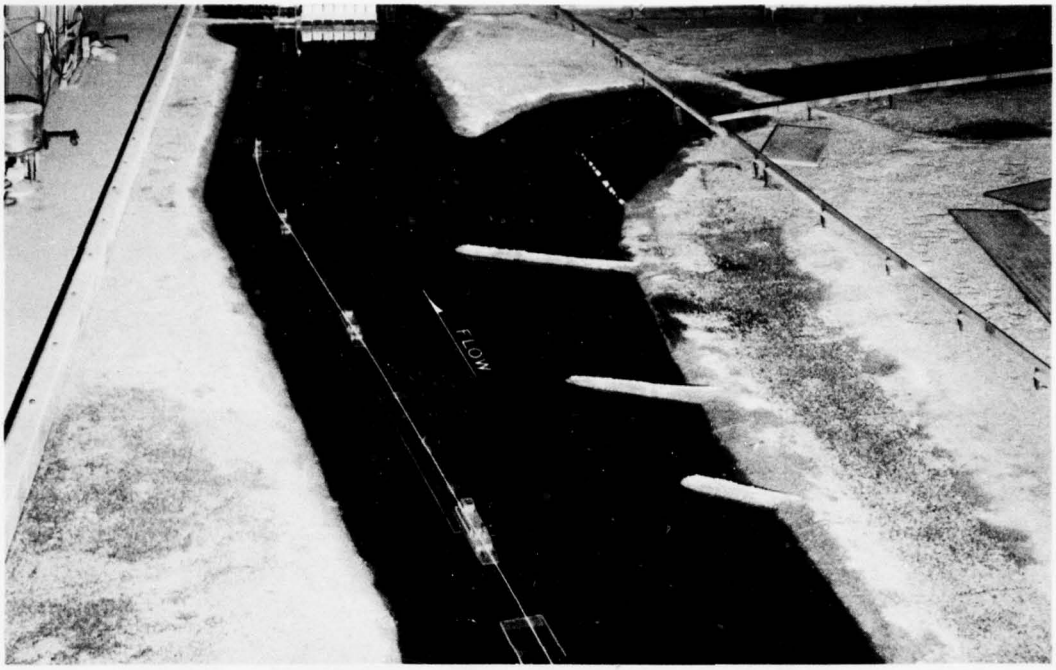
a. Path of downbound tow leaving lock



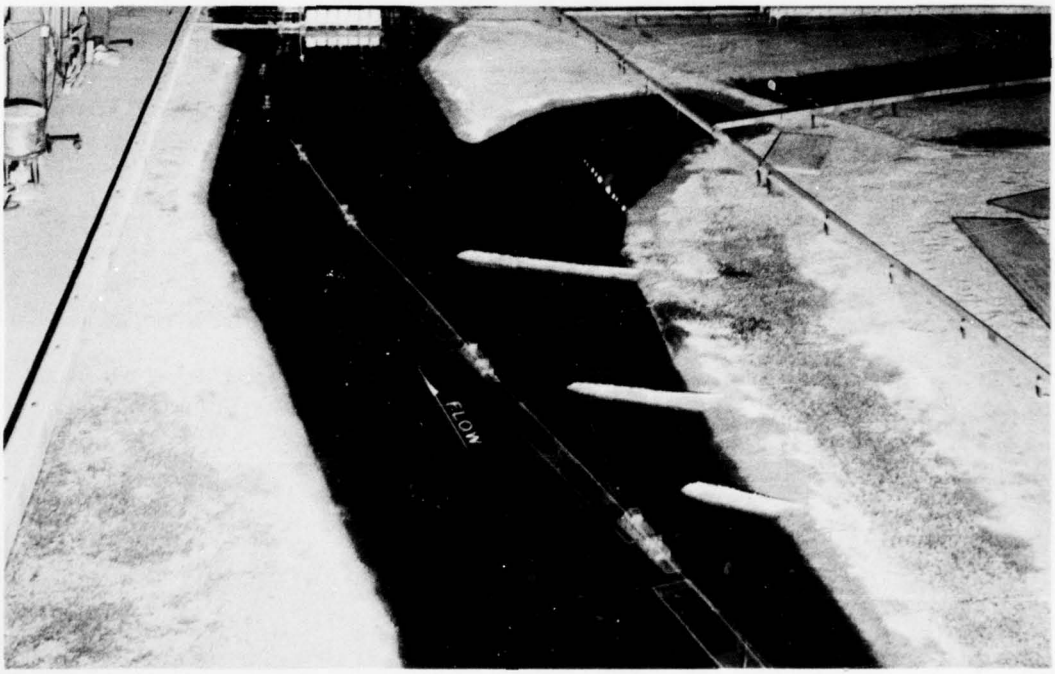
b. Path of upbound tow approaching lock

Photo 4. Plan D; discharge 58,000 cfs, lower pool el 56.2

Photo 5. Plan D-modified; discharge 58,000 cfs, upper pool el 58.0. Surface current directions; note eddy in lock approach

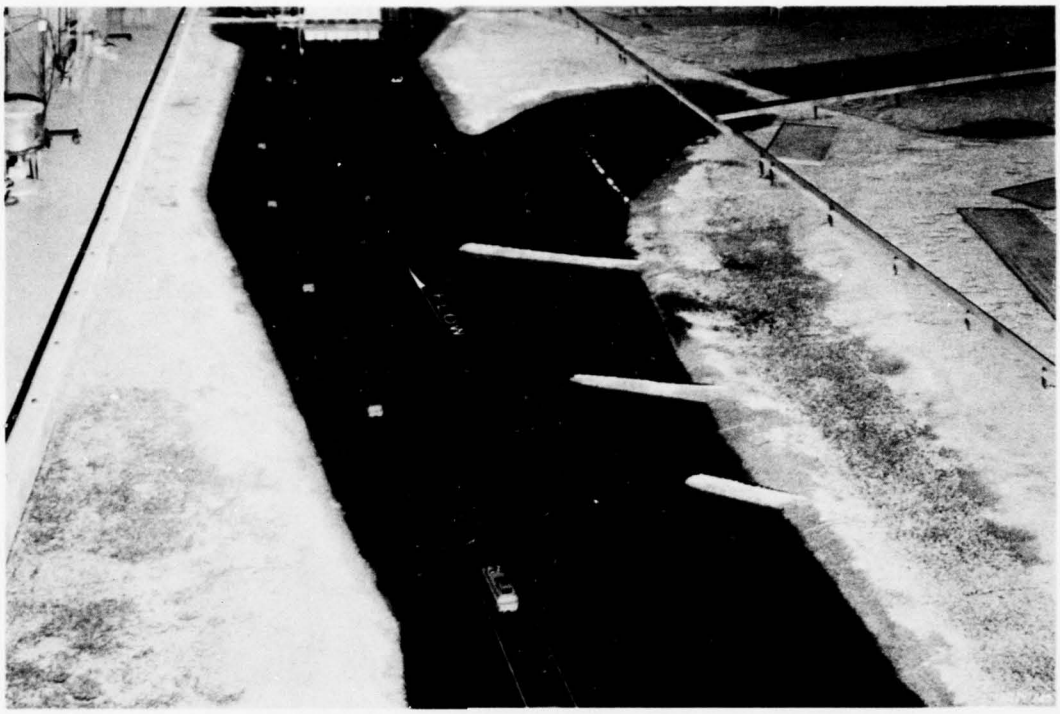


a. Approaching lock from along left bank with tow drifting from a considerable distance upstream of lock

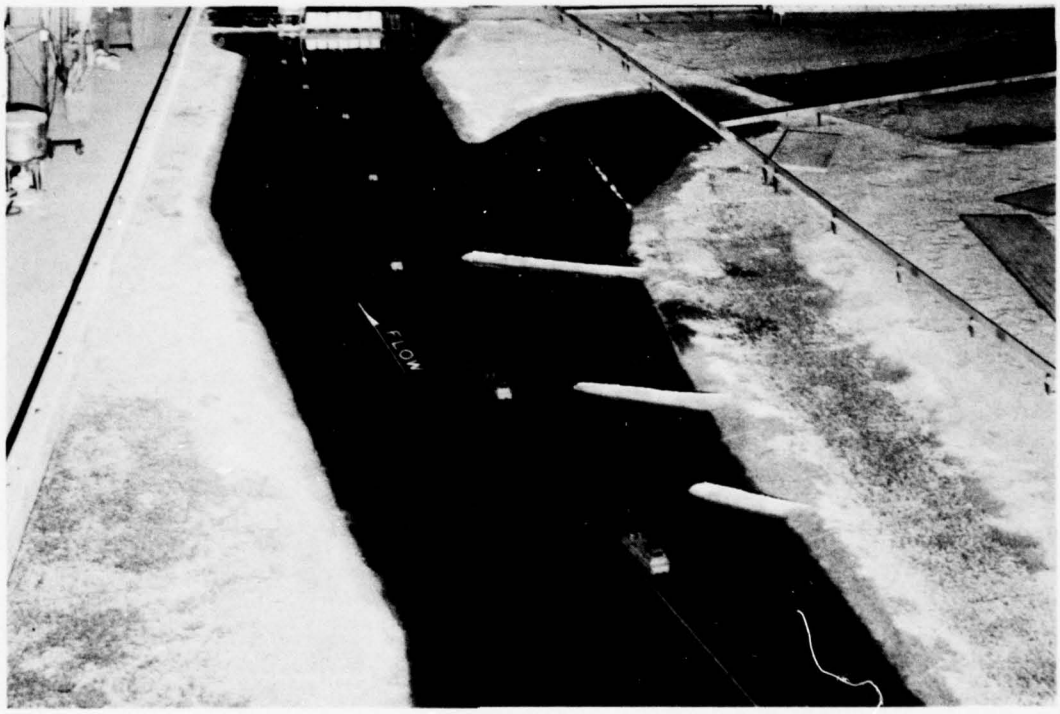


b. Approaching lock from right side of channel and drifting after making the turn toward lock

Photo 6. Plan D-modified; discharge 58,000 cfs, upper pool el 58.0. Paths of downbound tows



a. Leaving lock and proceeding upstream along right side after clearing end of upper guard wall



b. Leaving lock and proceeding upstream along left bank

Photo 7. Plan D-modified; discharge 58,000 cfs, upper pool el 58.0. Paths of upbound tows

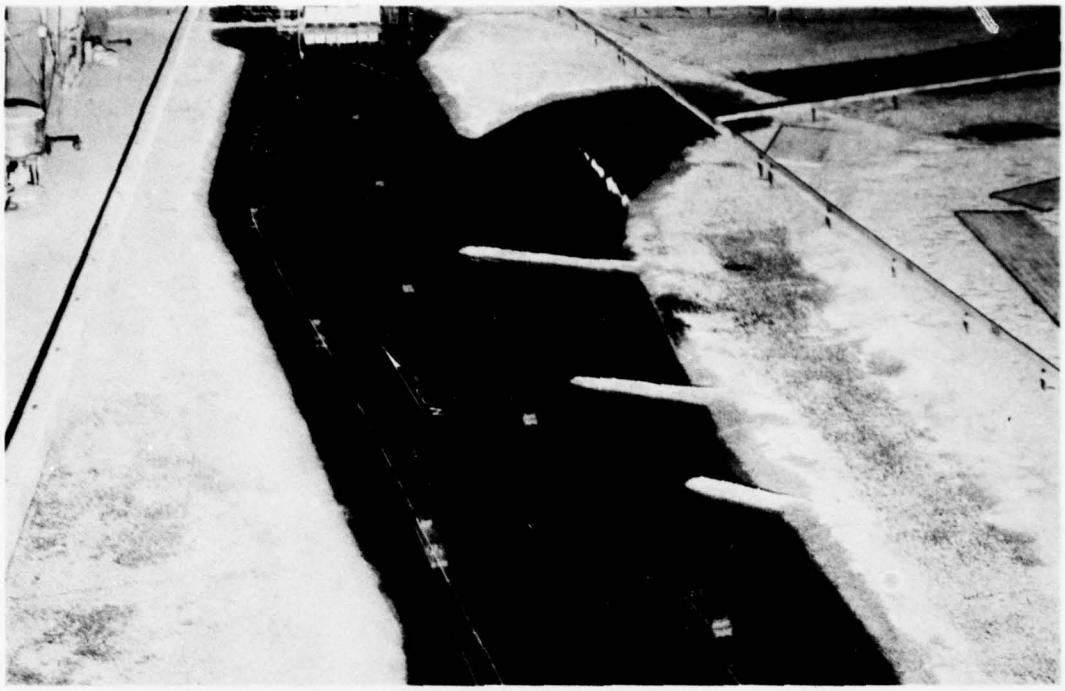


Photo 8. Plan D-modified; discharge 58,000 cfs, upper pool el 58.0. Paths of tows in upper lock approach. Downbound tow moving along left bank and upbound tow moving along right side

Photo 9. Plan E; discharge 58,000 cfs, lower pool el 56.2. Surface current direction; note eddy in lower lock approach

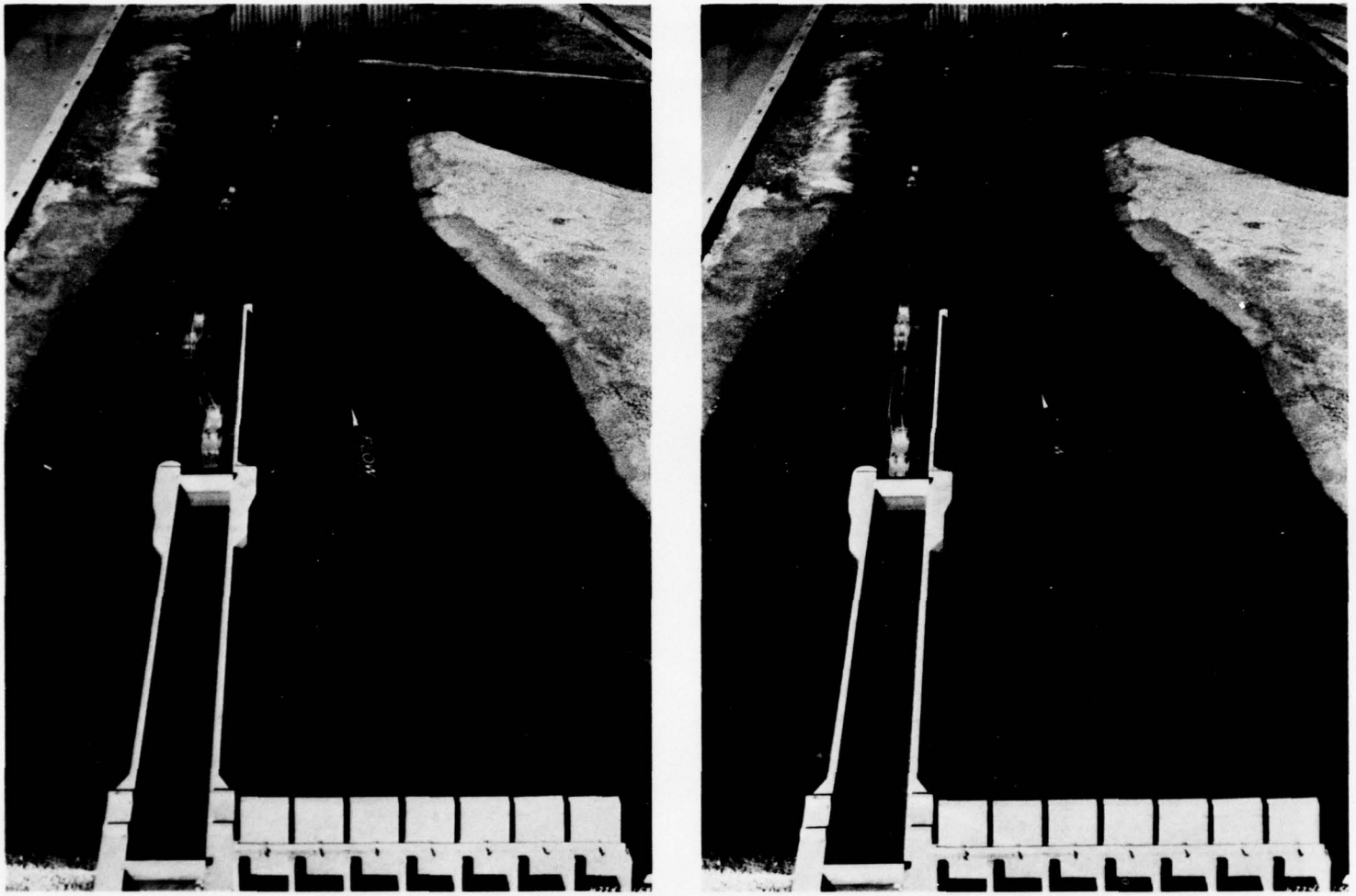
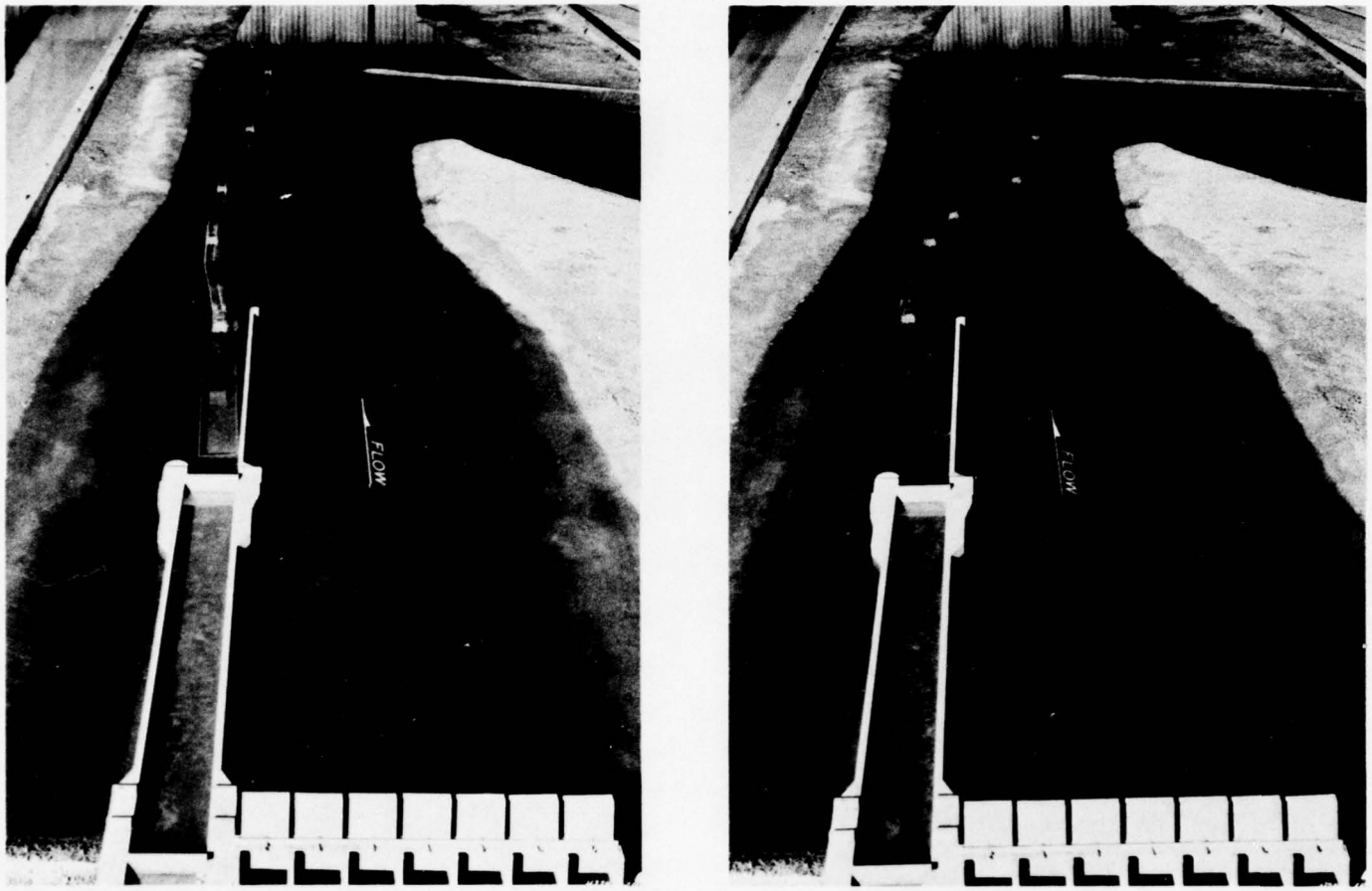


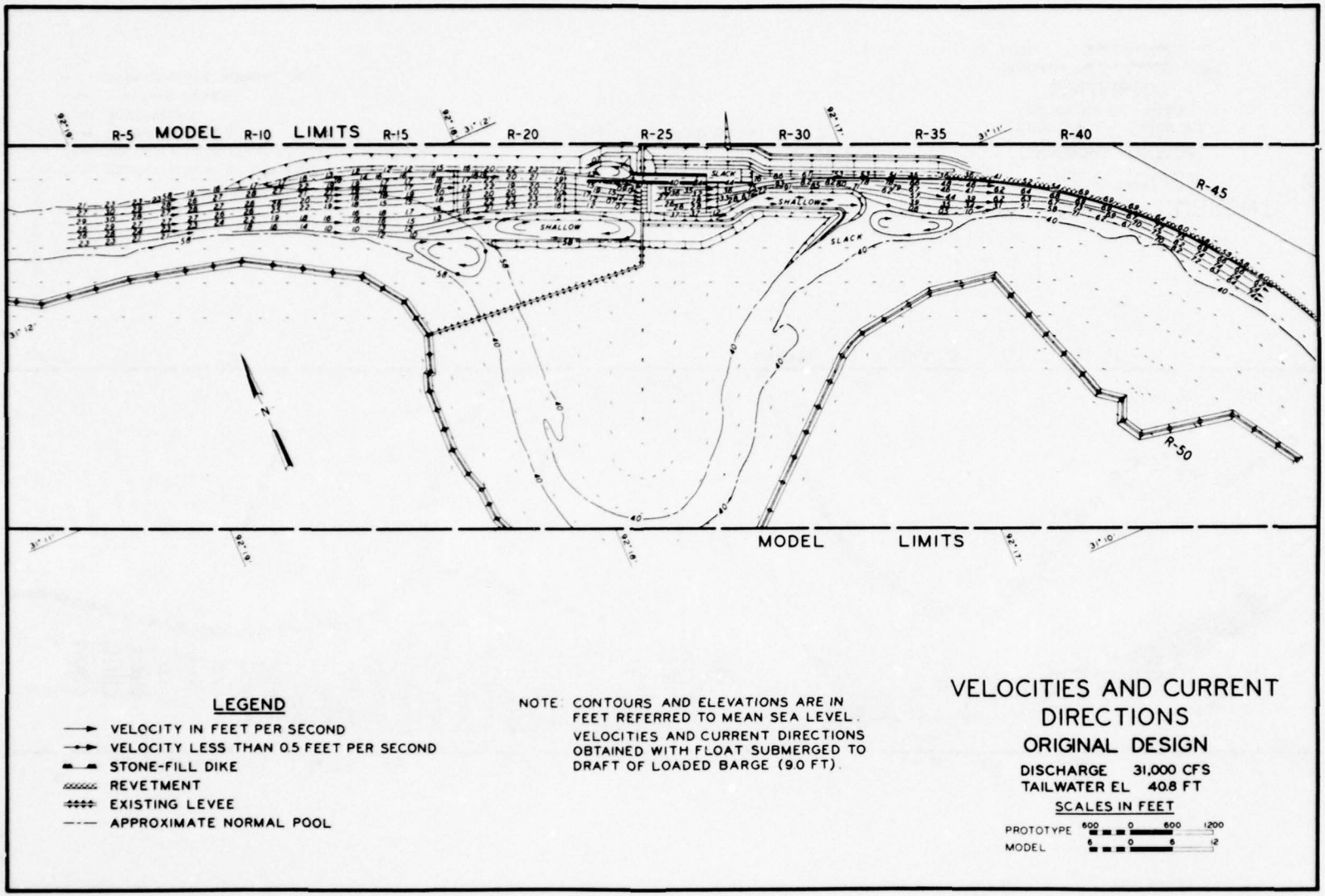
Photo 10. Plan E; discharge 58,000 cfs, lower pool el 56.2. Paths of downbound tows leaving lock; note tendency for tow to be moved toward left bank



a. Entering lock; note continuous change in alignment of tow and tendency to be moved toward left bank

b. Approaching lock from along right bank; note maneuvering required of towboat

Photo 11. Plan E; discharge 58,000 cfs, lower pool el 56.2. Paths of upbound tows



LEGEND

- VELOCITY IN FEET PER SECOND
- VELOCITY LESS THAN 0.5 FEET PER SECOND
- STONE-FILL DIKE
- REVETMENT
- EXISTING LEVEE
- APPROXIMATE NORMAL POOL

NOTE: CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO MEAN SEA LEVEL. VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (9.0 FT).

VELOCITIES AND CURRENT DIRECTIONS

ORIGINAL DESIGN

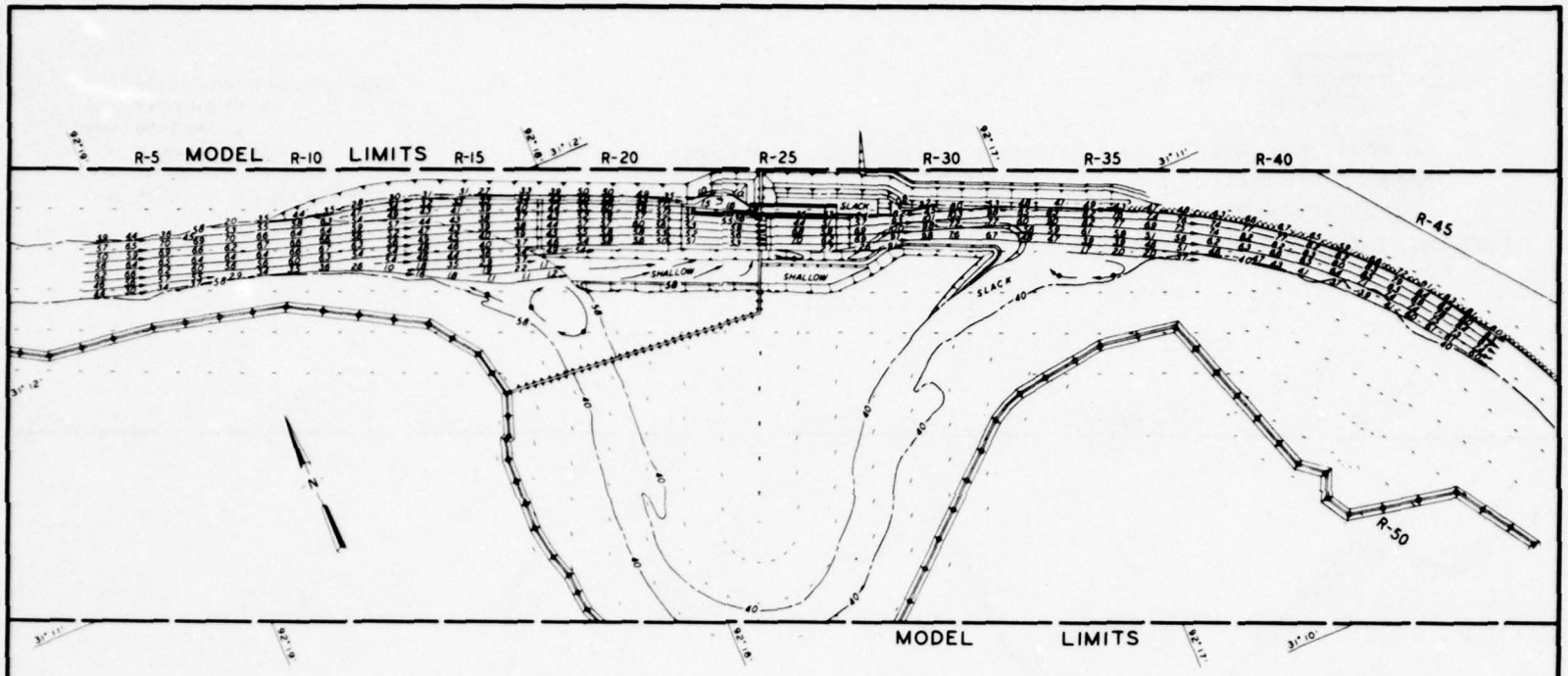
DISCHARGE 31,000 CFS
TAILWATER EL 40.8 FT

SCALES IN FEET

PROTOTYPE	600	0	600	1200
MODEL	6	0	6	12

PLATE 1

PLATE 2



LEGEND

- VELOCITY IN FEET PER SECOND
- VELOCITY LESS THAN 0.5 FEET PER SECOND
- STONE-FILL DIKE
- REVETMENT
- EXISTING LEVEE
- APPROXIMATE NORMAL POOL

NOTE: CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO MEAN SEA LEVEL. VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (9.0 FT).

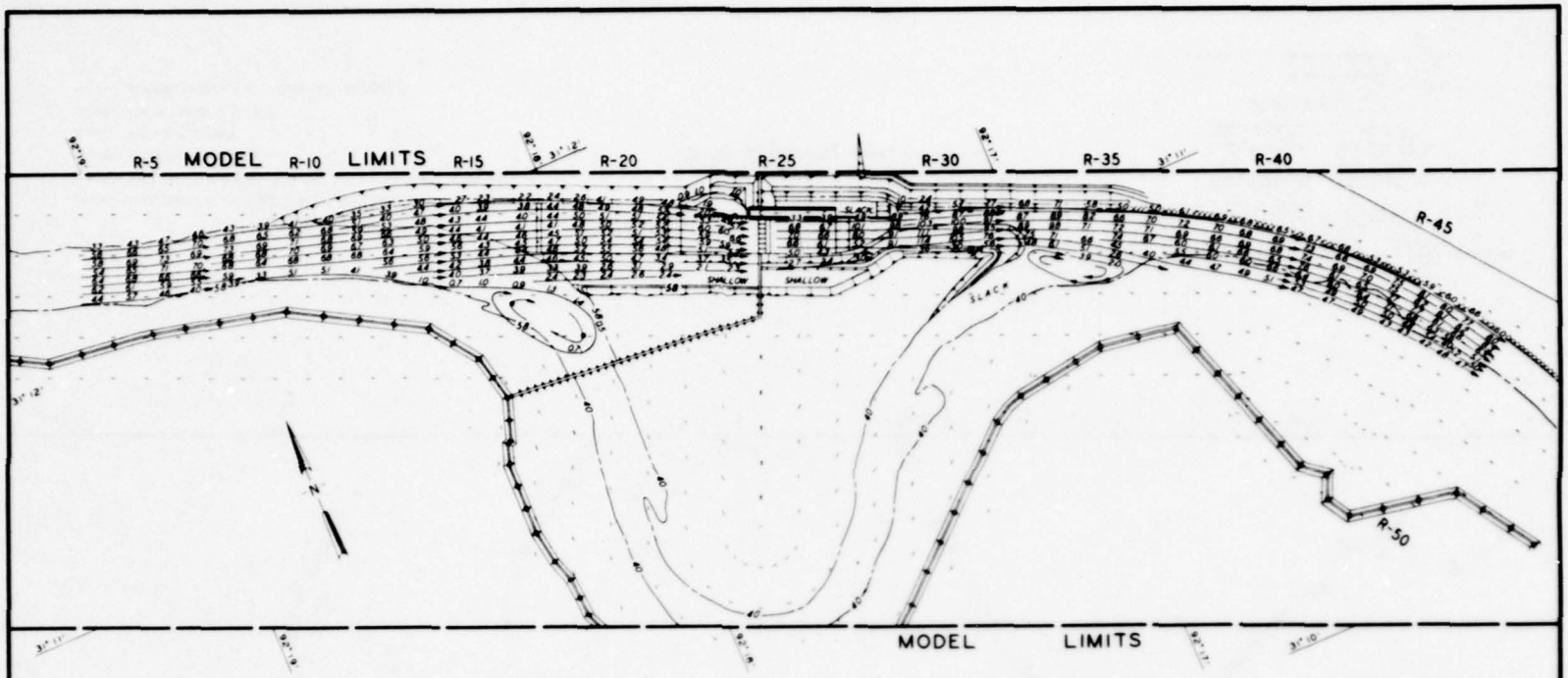
VELOCITIES AND CURRENT DIRECTIONS

ORIGINAL DESIGN

DISCHARGE 78,000 CFS
TAILWATER EL 53.8 FT

SCALES IN FEET

PROTOTYPE	600	0	600	1200
MODEL	6	0	6	12



LEGEND

- VELOCITY IN FEET PER SECOND
- VELOCITY LESS THAN 0.5 FEET PER SECOND
- STONE-FILL DIKE
- REVETMENT
- EXISTING LEVEE
- APPROXIMATE NORMAL POOL

NOTE: CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO MEAN SEA LEVEL.
VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (9.0 FT)

VELOCITIES AND CURRENT DIRECTIONS

ORIGINAL DESIGN

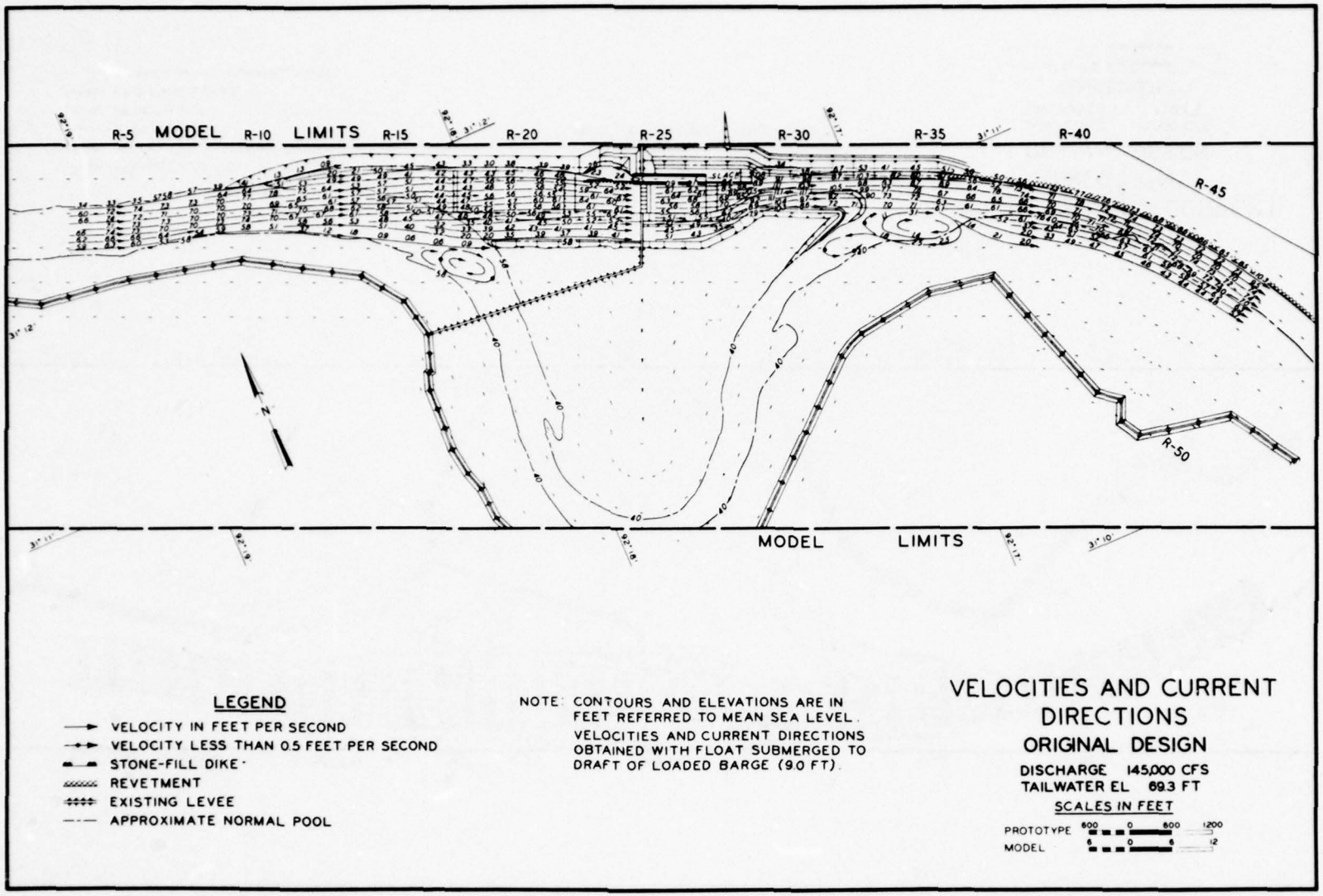
DISCHARGE 110,000 CFS
TAILWATER EL 61.9 FT

SCALES IN FEET

PROTOTYPE 600 0 600 1200
MODEL 6 0 6 12

PLATE 3

PLATE 4



LEGEND

- VELOCITY IN FEET PER SECOND
- VELOCITY LESS THAN 0.5 FEET PER SECOND
- STONE-FILL DIKE
- REVETMENT
- EXISTING LEVEE
- APPROXIMATE NORMAL POOL

NOTE: CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO MEAN SEA LEVEL.
VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (9.0 FT).

VELOCITIES AND CURRENT DIRECTIONS

ORIGINAL DESIGN

DISCHARGE 145,000 CFS
TAILWATER EL 69.3 FT

SCALES IN FEET

PROTOTYPE 600 0 600 1200
MODEL 6 0 6 12

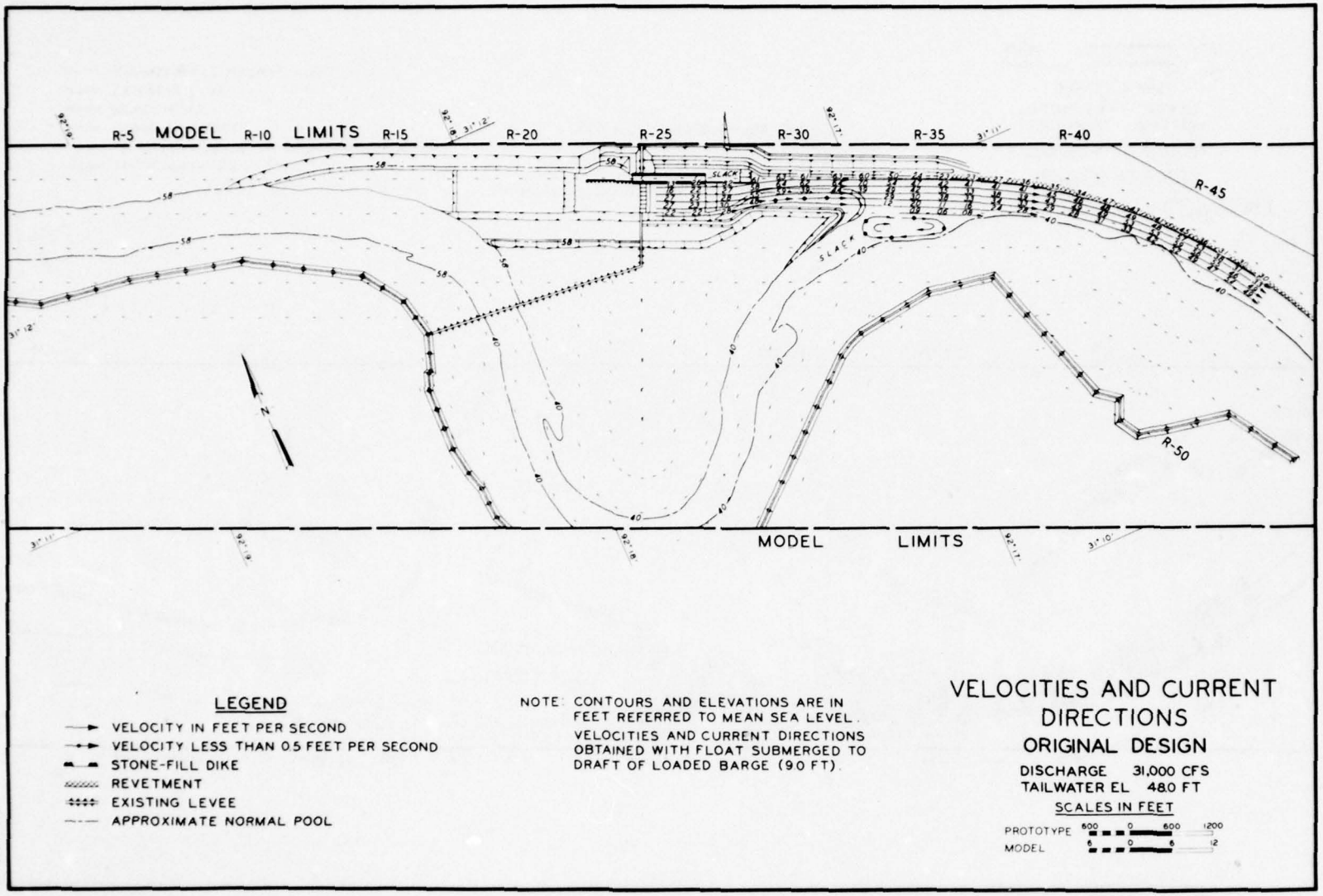


PLATE 5

LEGEND

- VELOCITY IN FEET PER SECOND
- VELOCITY LESS THAN 0.5 FEET PER SECOND
- STONE-FILL DIKE
- REVETMENT
- EXISTING LEVEE
- APPROXIMATE NORMAL POOL

NOTE: CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO MEAN SEA LEVEL.
VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (9.0 FT).

VELOCITIES AND CURRENT DIRECTIONS

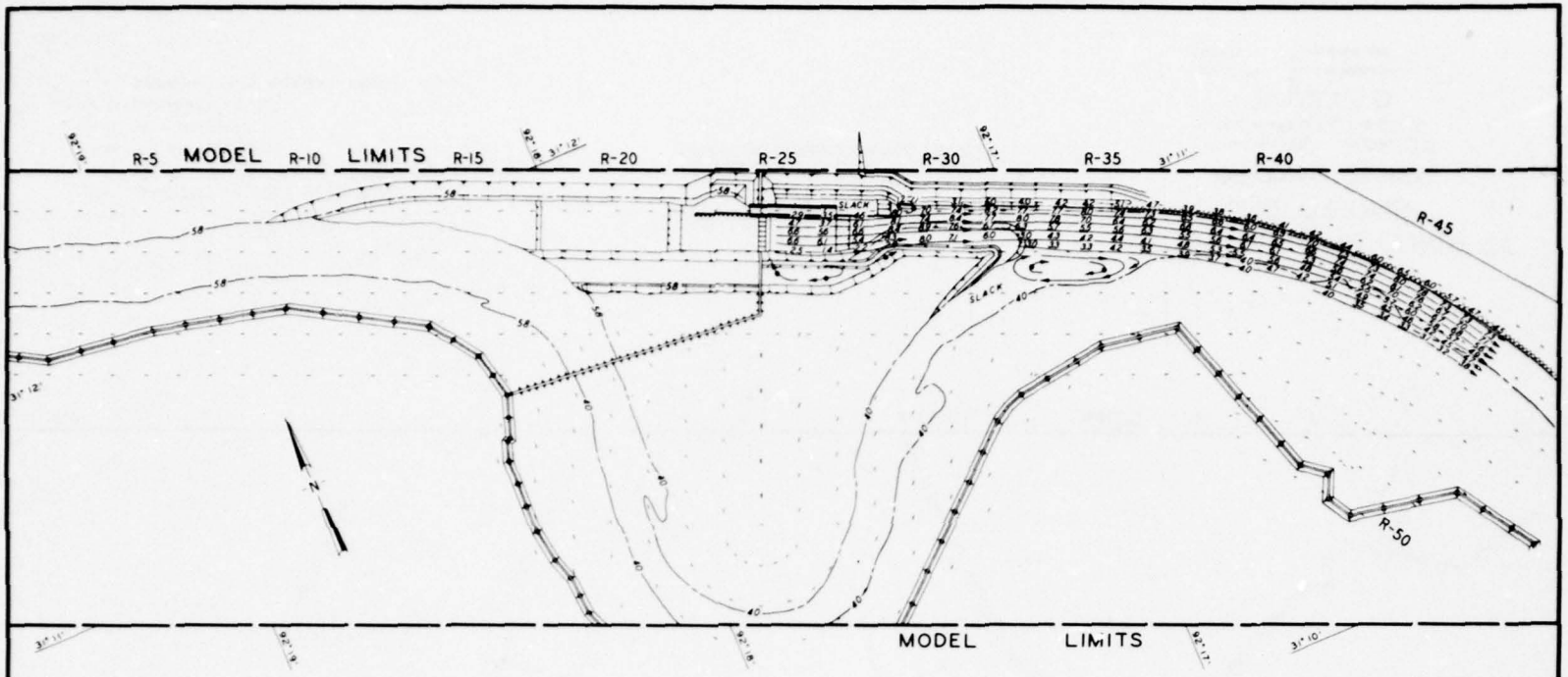
ORIGINAL DESIGN

DISCHARGE 31,000 CFS
TAILWATER EL 48.0 FT

SCALES IN FEET

PROTOTYPE 600 0 600 1200
MODEL 6 0 6 12

PLATE 6



LEGEND

- VELOCITY IN FEET PER SECOND
- VELOCITY LESS THAN 0.5 FEET PER SECOND
- STONE-FILL DIKE
- REVETMENT
- EXISTING LEVEE
- APPROXIMATE NORMAL POOL

NOTE: CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO MEAN SEA LEVEL.
VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (9.0 FT).

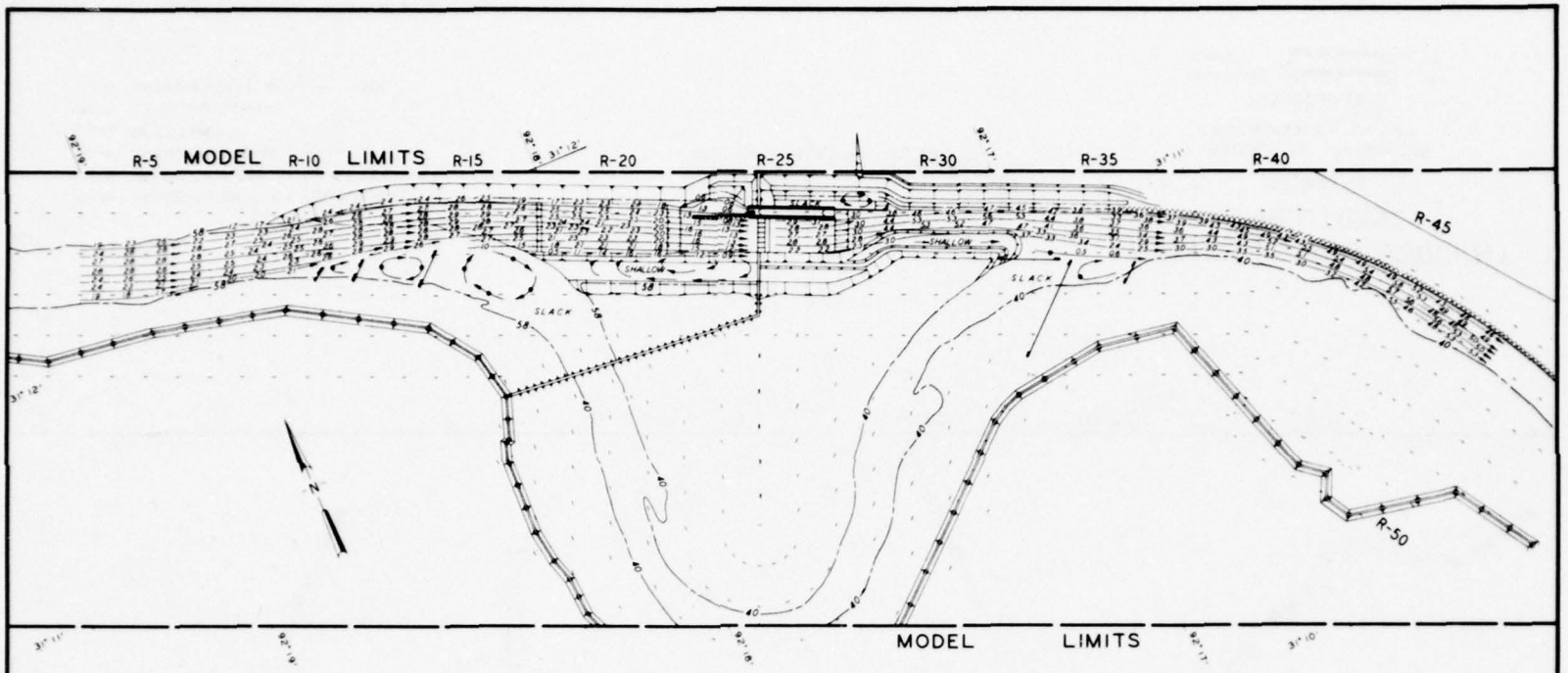
VELOCITIES AND CURRENT DIRECTIONS

ORIGINAL DESIGN

DISCHARGE: 78,000 CFS
TAILWATER EL 56.3 FT

SCALES IN FEET

PROTOTYPE 600 0 600 1200
MODEL 6 0 6 12



LEGEND

- VELOCITY IN FEET PER SECOND
- VELOCITY LESS THAN 0.5 FEET PER SECOND
- STONE-FILL DIKE
- REVETMENT
- EXISTING LEVEE
- APPROXIMATE NORMAL POOL

NOTE: CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO MEAN SEA LEVEL.
VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (9.0 FT).

VELOCITIES AND CURRENT DIRECTIONS

PLAN A

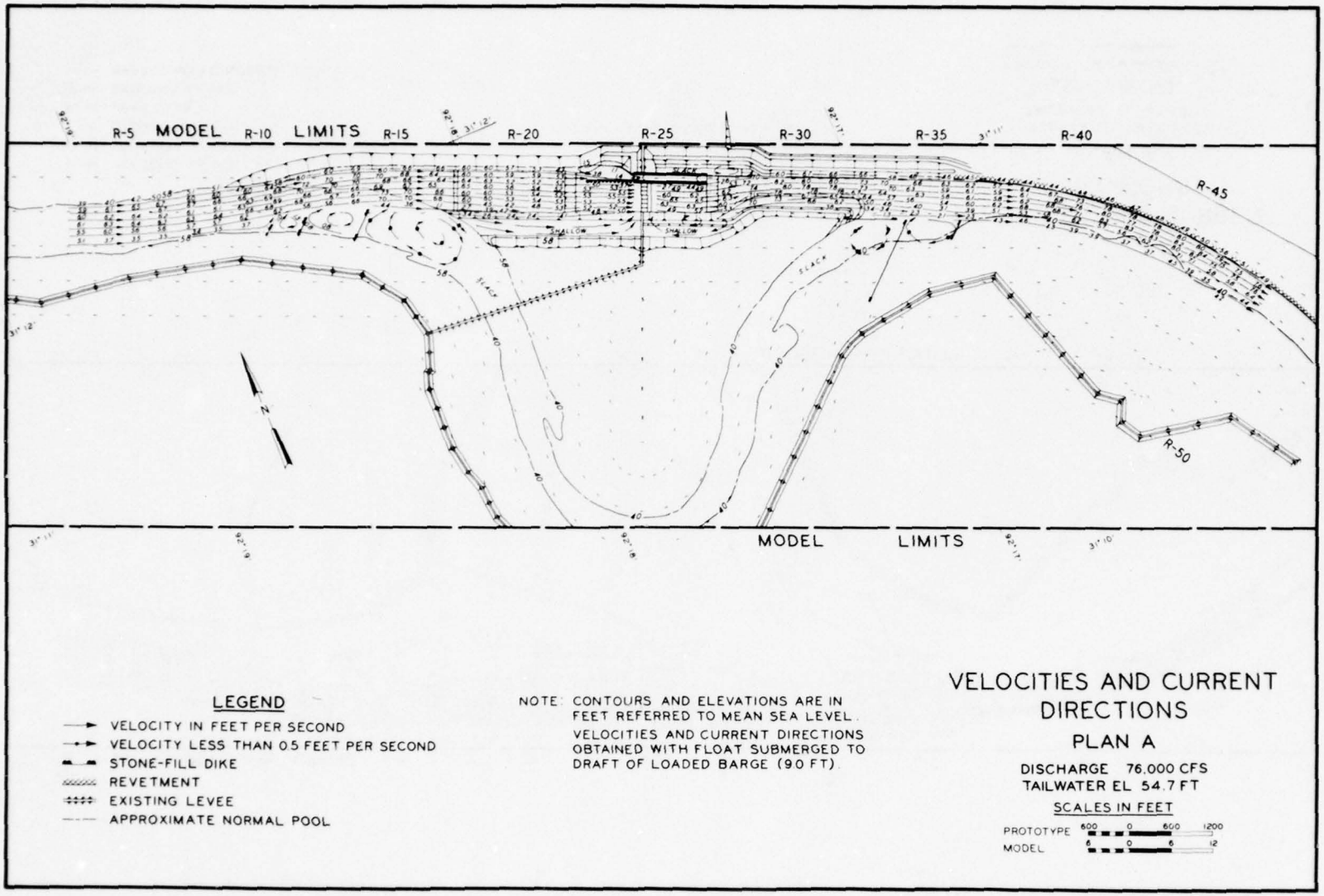
DISCHARGE 31,000 CFS
TAILWATER EL 47.4 FT

SCALES IN FEET

PROTOTYPE 600 0 600 1200
MODEL 6 0 6 12

PLATE 7

PLATE 8



LEGEND

- VELOCITY IN FEET PER SECOND
- VELOCITY LESS THAN 0.5 FEET PER SECOND
- STONE-FILL DIKE
- REVETMENT
- EXISTING LEVEE
- APPROXIMATE NORMAL POOL

NOTE: CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO MEAN SEA LEVEL. VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (9.0 FT).

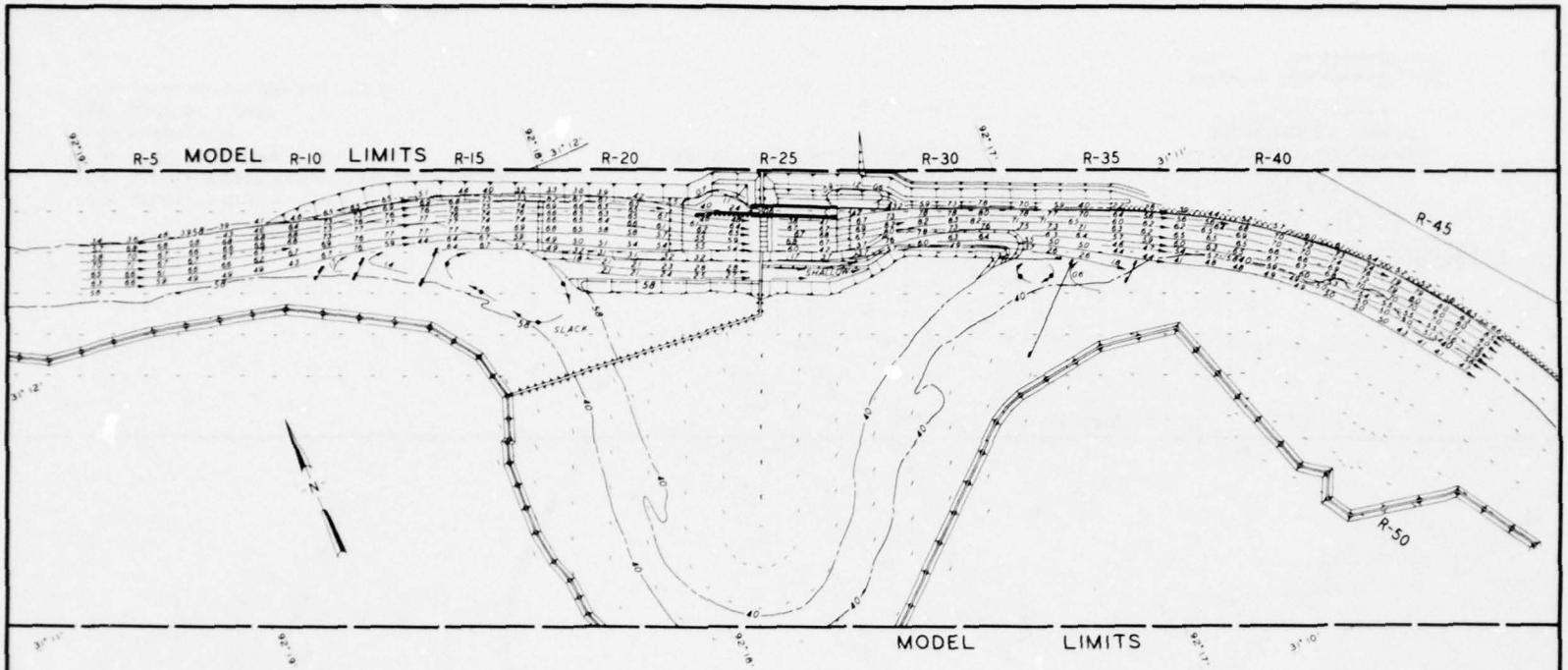
VELOCITIES AND CURRENT DIRECTIONS

PLAN A

DISCHARGE 76,000 CFS
TAILWATER EL 54.7 FT

SCALES IN FEET

PROTOTYPE	600	0	600	1200
MODEL	6	0	6	12



LEGEND

- VELOCITY IN FEET PER SECOND
- VELOCITY LESS THAN 0.5 FEET PER SECOND
- STONE-FILL DIKE
- REVETMENT
- EXISTING LEVEE
- APPROXIMATE NORMAL POOL

NOTE: CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO MEAN SEA LEVEL.
VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (9.0 FT).

VELOCITIES AND CURRENT DIRECTIONS

PLAN A

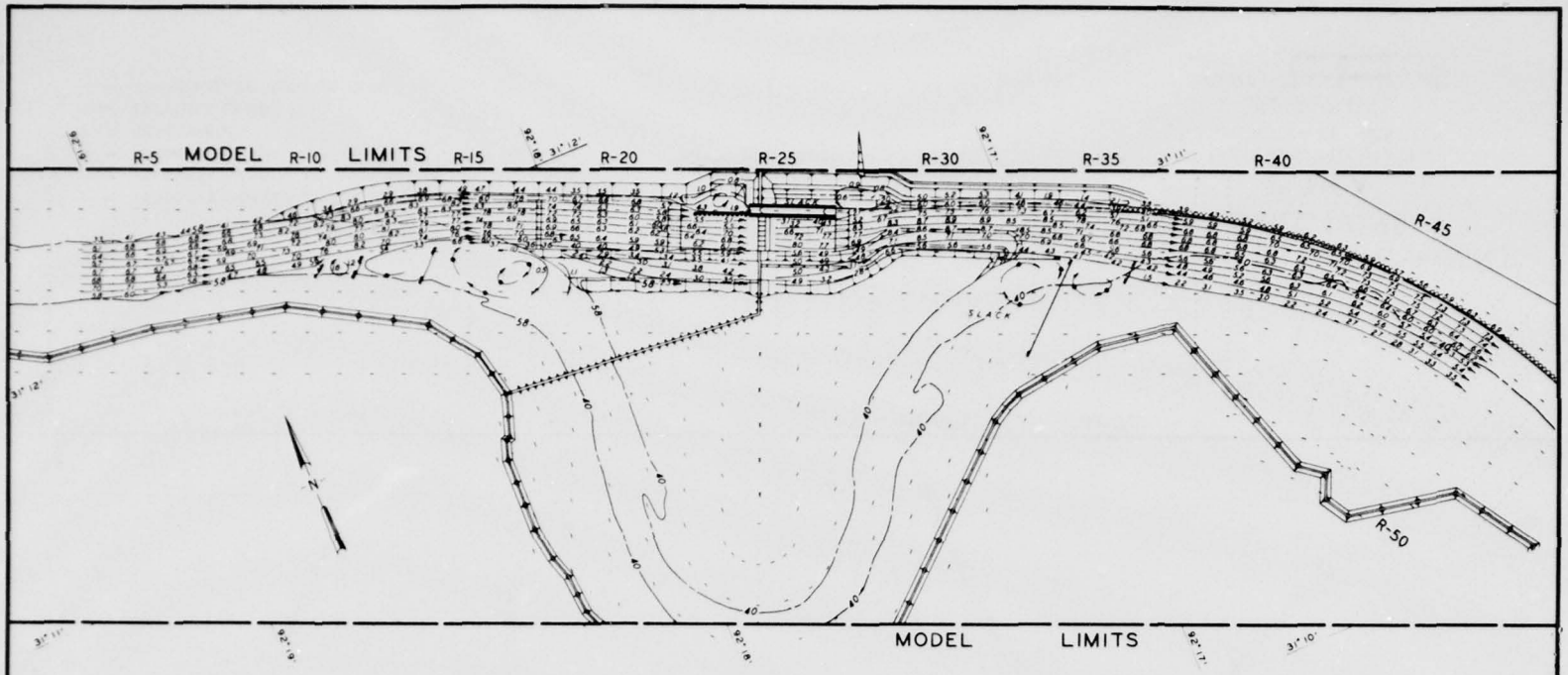
DISCHARGE 110,000 CFS
TAILWATER EL 62.5 FT

SCALES IN FEET

PROTOTYPE	600	0	600	1200
MODEL	6	0	6	12

PLATE 9

PLATE 10



LEGEND

- VELOCITY IN FEET PER SECOND
- VELOCITY LESS THAN 0.5 FEET PER SECOND
- STONE-FILL DIKE
- REVETMENT
- EXISTING LEVEE
- APPROXIMATE NORMAL POOL

NOTE: CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO MEAN SEA LEVEL. VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (9.0 FT).

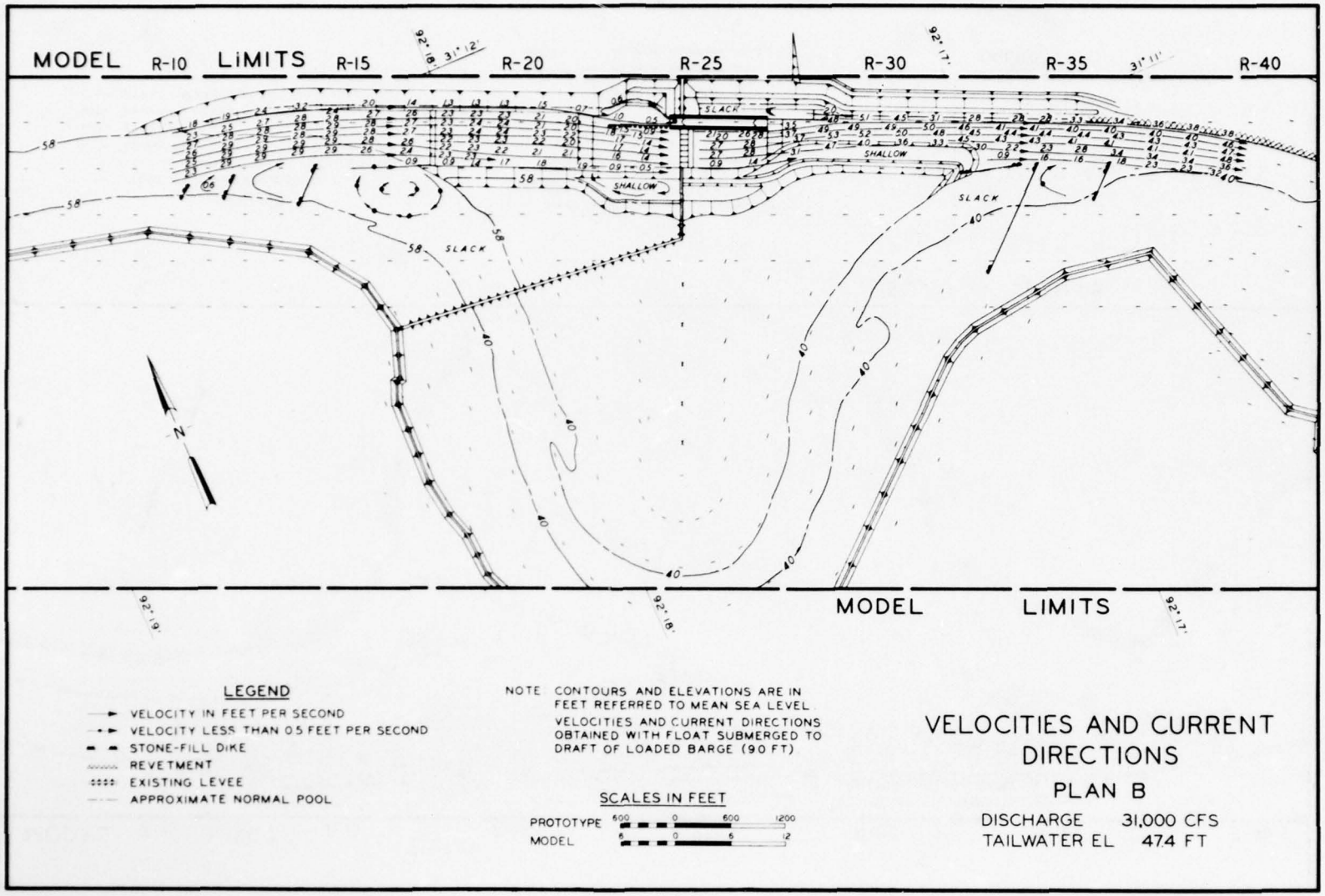
VELOCITIES AND CURRENT DIRECTIONS

PLAN A

DISCHARGE 145,000 CFS
TAILWATER EL 69.9 FT

SCALES IN FEET

PROTOTYPE	600	0	600	1200
MODEL	6	0	6	12



LEGEND

- VELOCITY IN FEET PER SECOND
- VELOCITY LESS THAN 0.5 FEET PER SECOND
- STONE-FILL DIKE
- REVETMENT
- EXISTING LEVEE
- APPROXIMATE NORMAL POOL

NOTE CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO MEAN SEA LEVEL
VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (90 FT)

SCALES IN FEET

PROTOTYPE 600 0 600 1200
MODEL 6 0 6 12

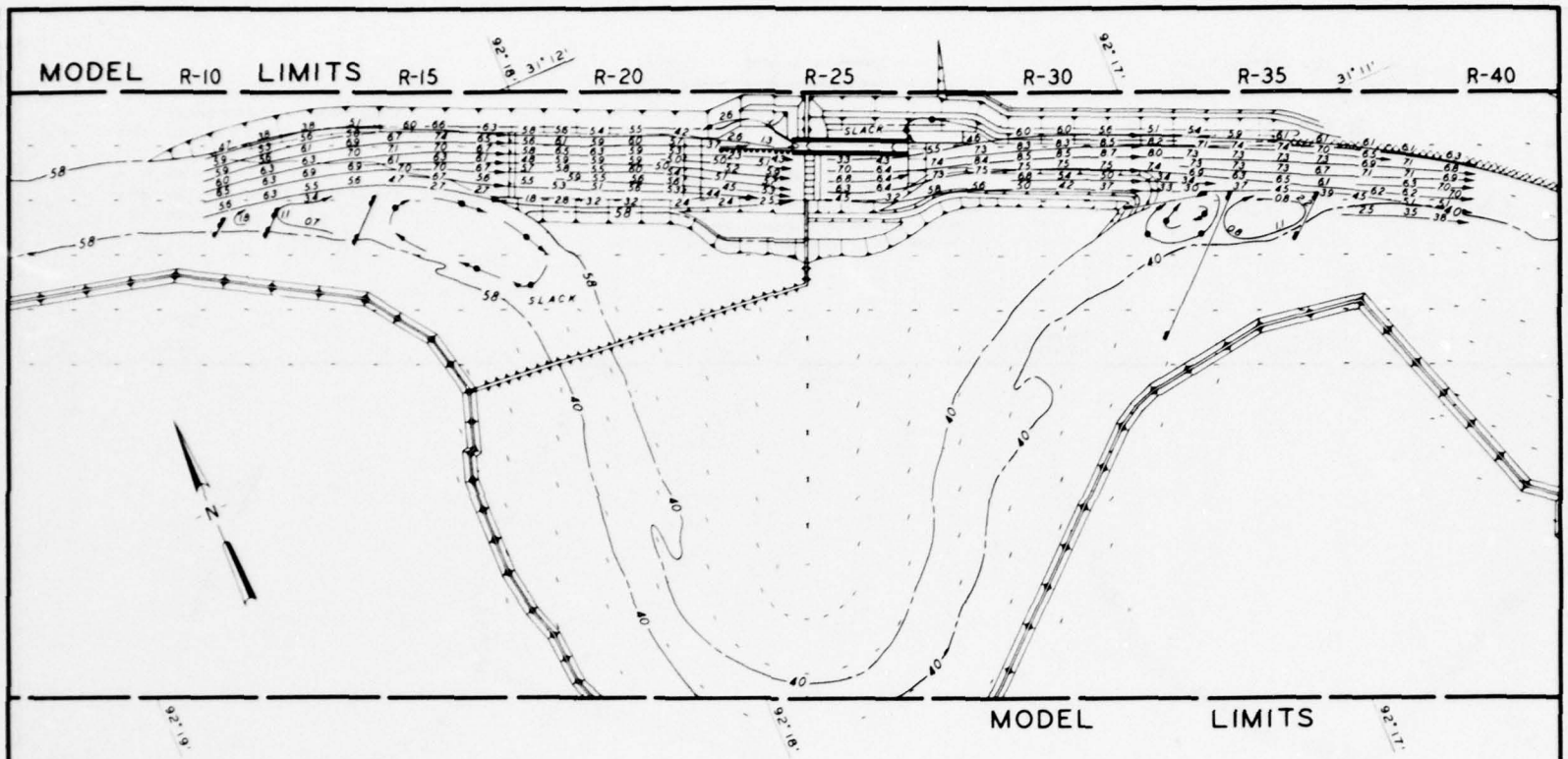
VELOCITIES AND CURRENT DIRECTIONS

PLAN B

DISCHARGE 31,000 CFS
TAILWATER EL 47.4 FT

PLATE 11

PLATE 12



LEGEND

- VELOCITY IN FEET PER SECOND
- VELOCITY LESS THAN 0.5 FEET PER SECOND
- STONE-FILL DIKE
- REVETMENT
- EXISTING LEVEE
- APPROXIMATE NORMAL POOL

NOTE CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO MEAN SEA LEVEL

VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (9.0 FT)

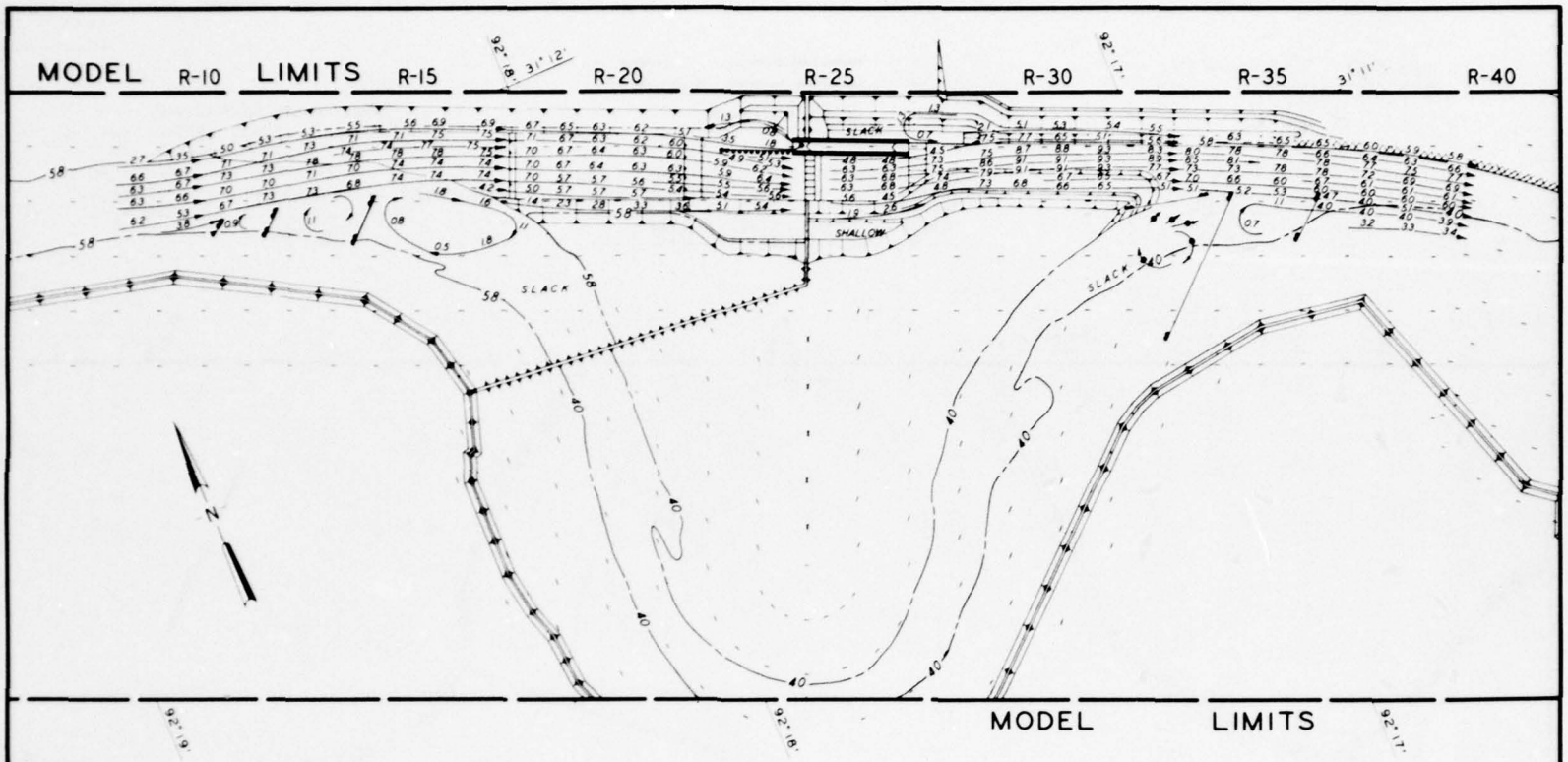
SCALES IN FEET

PROTOTYPE	600	0	600	1200
MODEL	6	0	6	12

VELOCITIES AND CURRENT DIRECTIONS

PLAN B

DISCHARGE 76,000 CFS
TAILWATER EL 54.7 FT



LEGEND

- VELOCITY IN FEET PER SECOND
- VELOCITY LESS THAN 0.5 FEET PER SECOND
- STONE-FILL DIKE
- REVETMENT
- EXISTING LEVEE
- APPROXIMATE NORMAL POOL

NOTE CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO MEAN SEA LEVEL. VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (90 FT)

SCALES IN FEET

PROTOTYPE	600	0	600	1200
MODEL	6	0	6	12

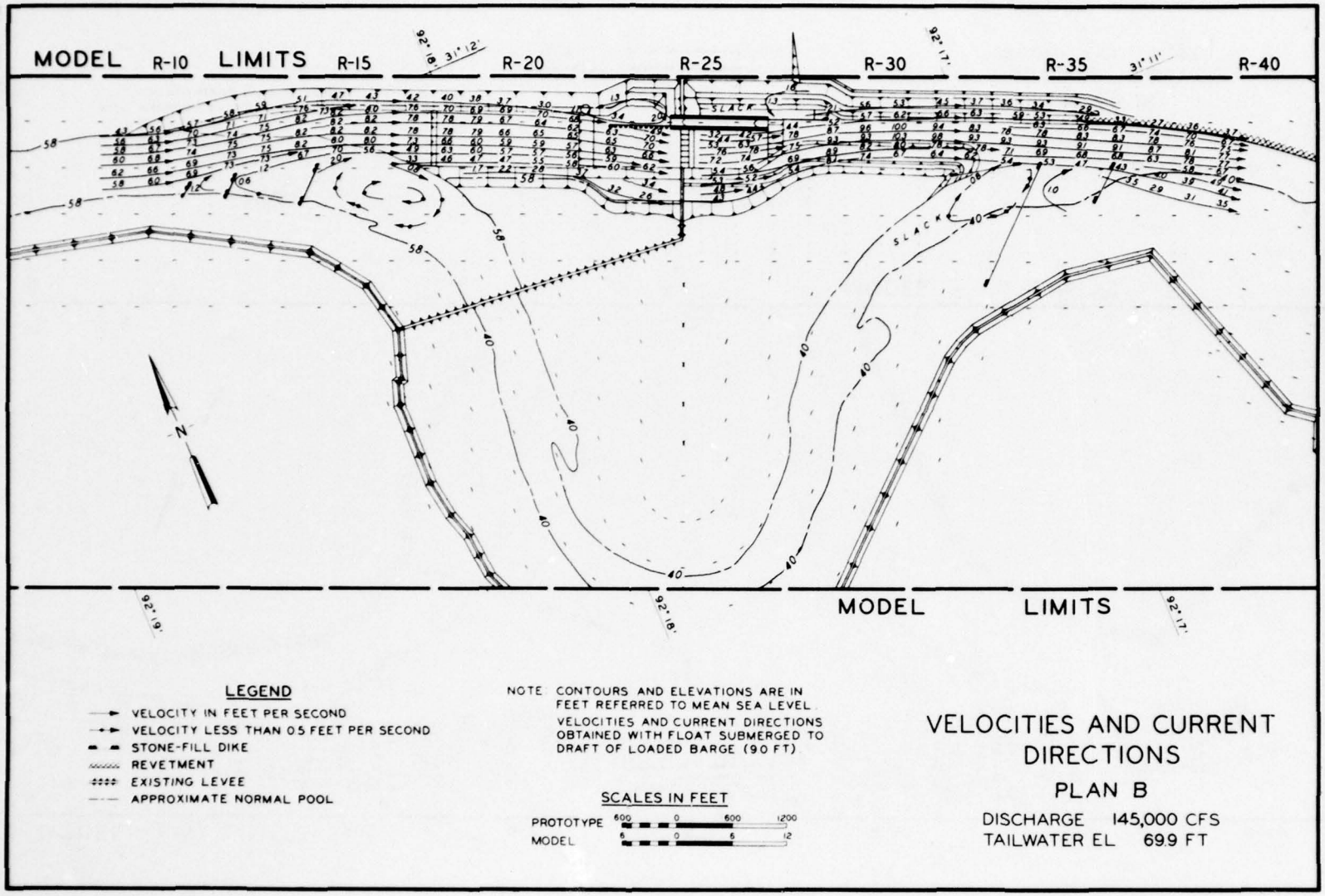
VELOCITIES AND CURRENT DIRECTIONS

PLAN B

DISCHARGE 110,000 CFS
TAILWATER EL 62.5 FT

PLATE 13

PLATE 14



LEGEND

- VELOCITY IN FEET PER SECOND
- VELOCITY LESS THAN 0.5 FEET PER SECOND
- STONE-FILL DIKE
- REVETMENT
- EXISTING LEVEE
- APPROXIMATE NORMAL POOL

NOTE: CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO MEAN SEA LEVEL. VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (9.0 FT.)

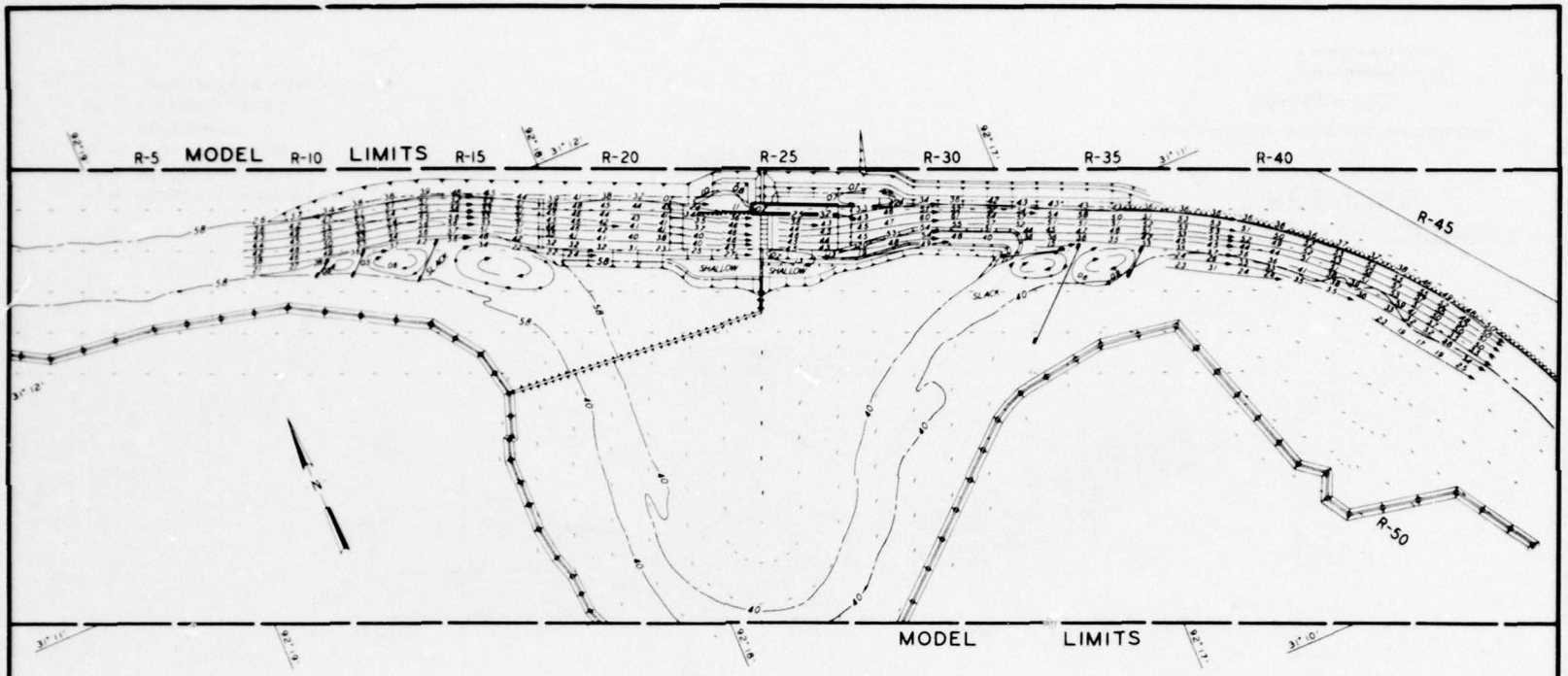
SCALES IN FEET

PROTOTYPE	600	0	600	1200
MODEL	6	0	6	12

VELOCITIES AND CURRENT DIRECTIONS

PLAN B

DISCHARGE 145,000 CFS
TAILWATER EL 69.9 FT



LEGEND

- VELOCITY IN FEET PER SECOND
- VELOCITY LESS THAN 0.5 FEET PER SECOND
- STONE-FILL DIKE
- REVETMENT
- EXISTING LEVEE
- APPROXIMATE NORMAL POOL

NOTE: CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO MEAN SEA LEVEL.
VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (9.0 FT).

VELOCITIES AND CURRENT DIRECTIONS

PLAN C

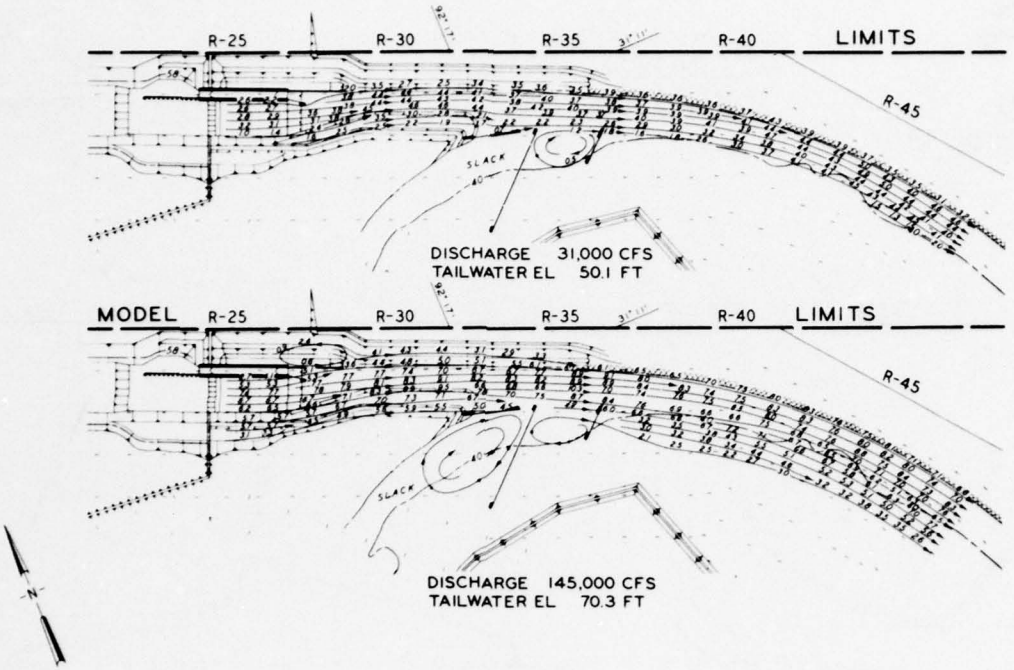
DISCHARGE 58,000 CFS
TAILWATER EL 56.2 FT

SCALES IN FEET

PROTOTYPE 600 0 600 1200
MODEL 6 0 6 12

PLATE 15

PLATE 16



LEGEND

- VELOCITY IN FEET PER SECOND
- VELOCITY LESS THAN 0.5 FEET PER SECOND
- STONE-FILL DIKE
- REVETMENT
- EXISTING LEVEE
- APPROXIMATE NORMAL POOL

NOTE CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO MEAN SEA LEVEL.
VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (9.0 FT).

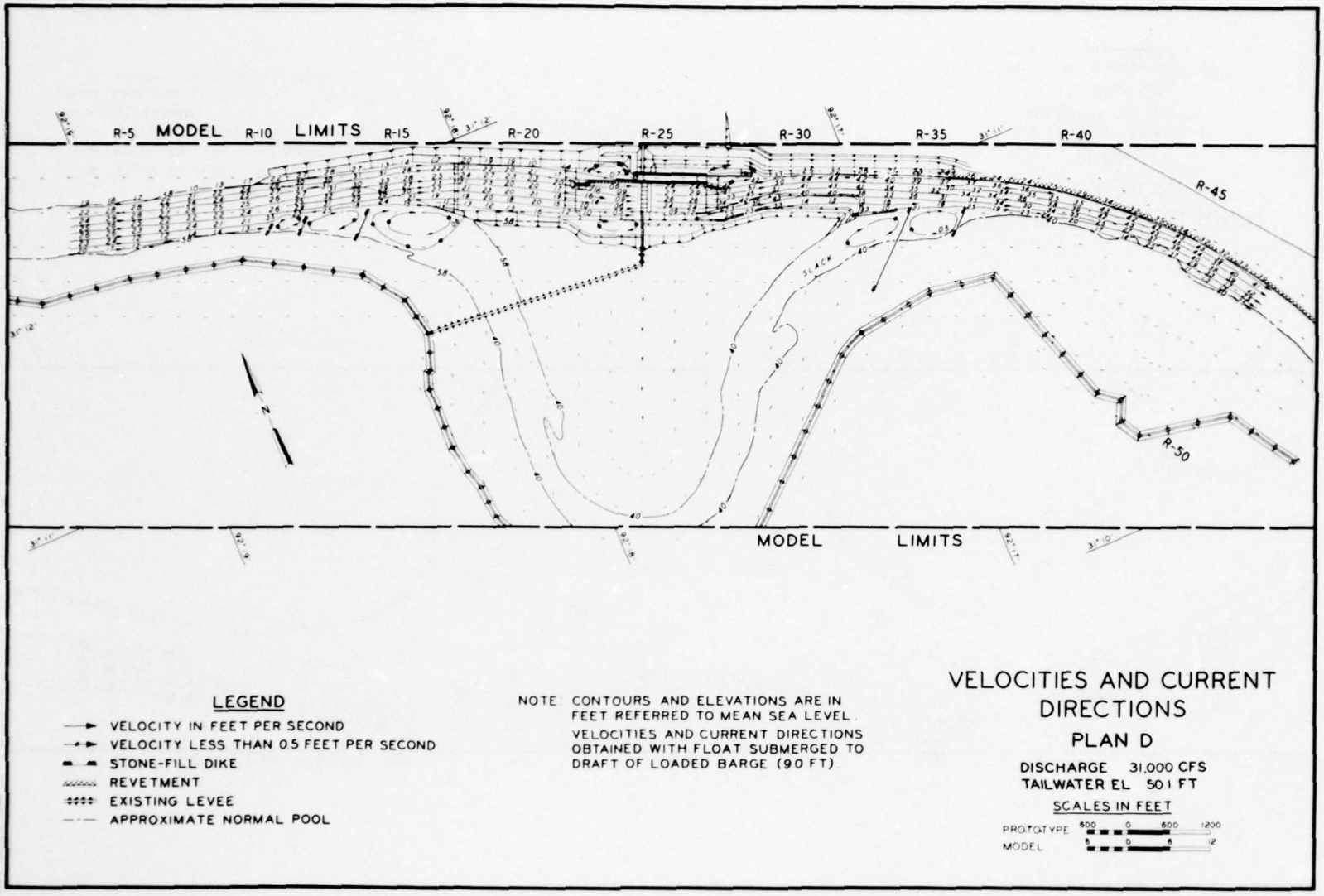
VELOCITIES AND CURRENT DIRECTIONS

PLAN C

DISCHARGES 31,000 AND 145,000 CFS

SCALES IN FEET

PROTOTYPE 600 0 600 1200
MODEL 6 0 6 12



LEGEND

- VELOCITY IN FEET PER SECOND
- VELOCITY LESS THAN 0.5 FEET PER SECOND
- STONE-FILL DIKE
- REVETMENT
- EXISTING LEVEE
- APPROXIMATE NORMAL POOL

NOTE: CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO MEAN SEA LEVEL.
VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (9.0 FT).

VELOCITIES AND CURRENT DIRECTIONS

PLAN D

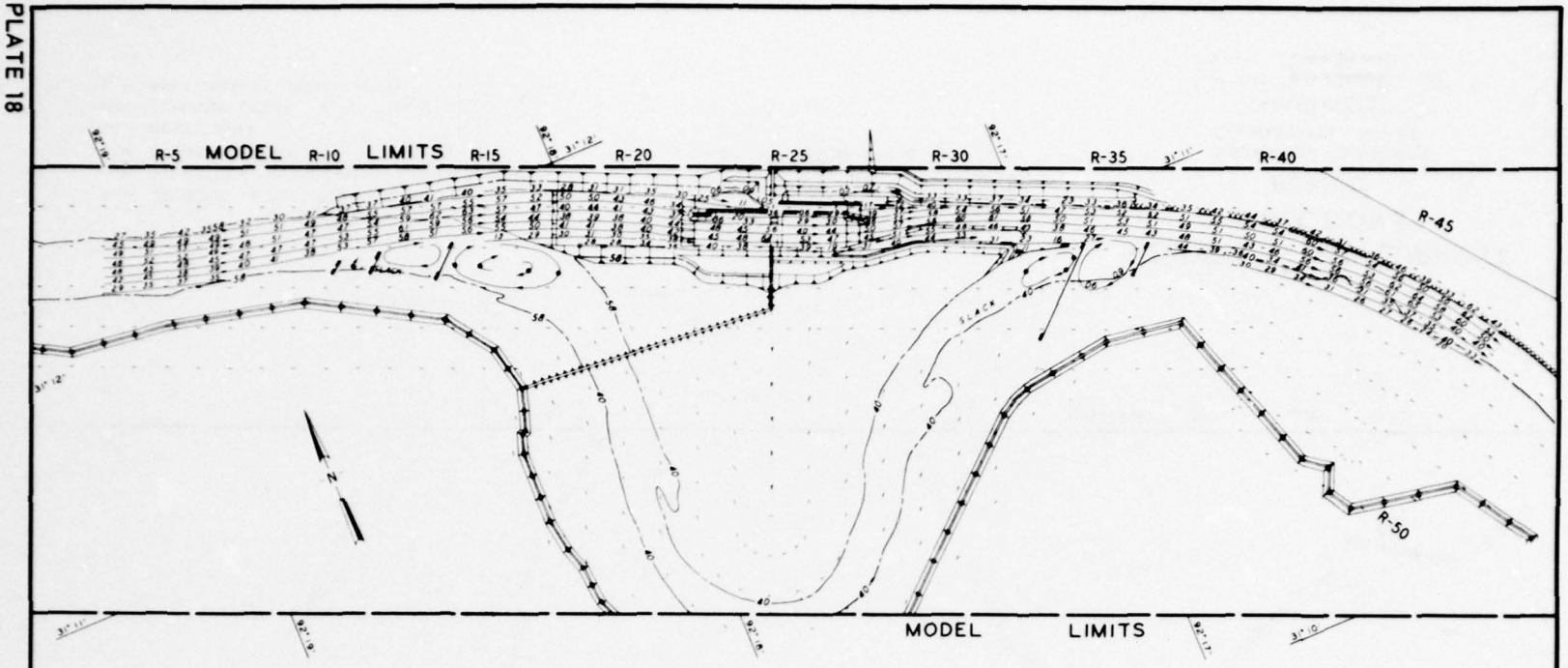
DISCHARGE 31,000 CFS
TAILWATER EL 50.1 FT

SCALES IN FEET

PROTOTYPE 600 0 600 1200
MODEL 6 0 6 12

PLATE 17

PLATE 18



LEGEND

- VELOCITY IN FEET PER SECOND
- VELOCITY LESS THAN 0.5 FEET PER SECOND
- STONE-FILL DIKE
- REVETMENT
- EXISTING LEVEE
- APPROXIMATE NORMAL POOL

NOTE: CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO MEAN SEA LEVEL.
VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (9.0 FT).

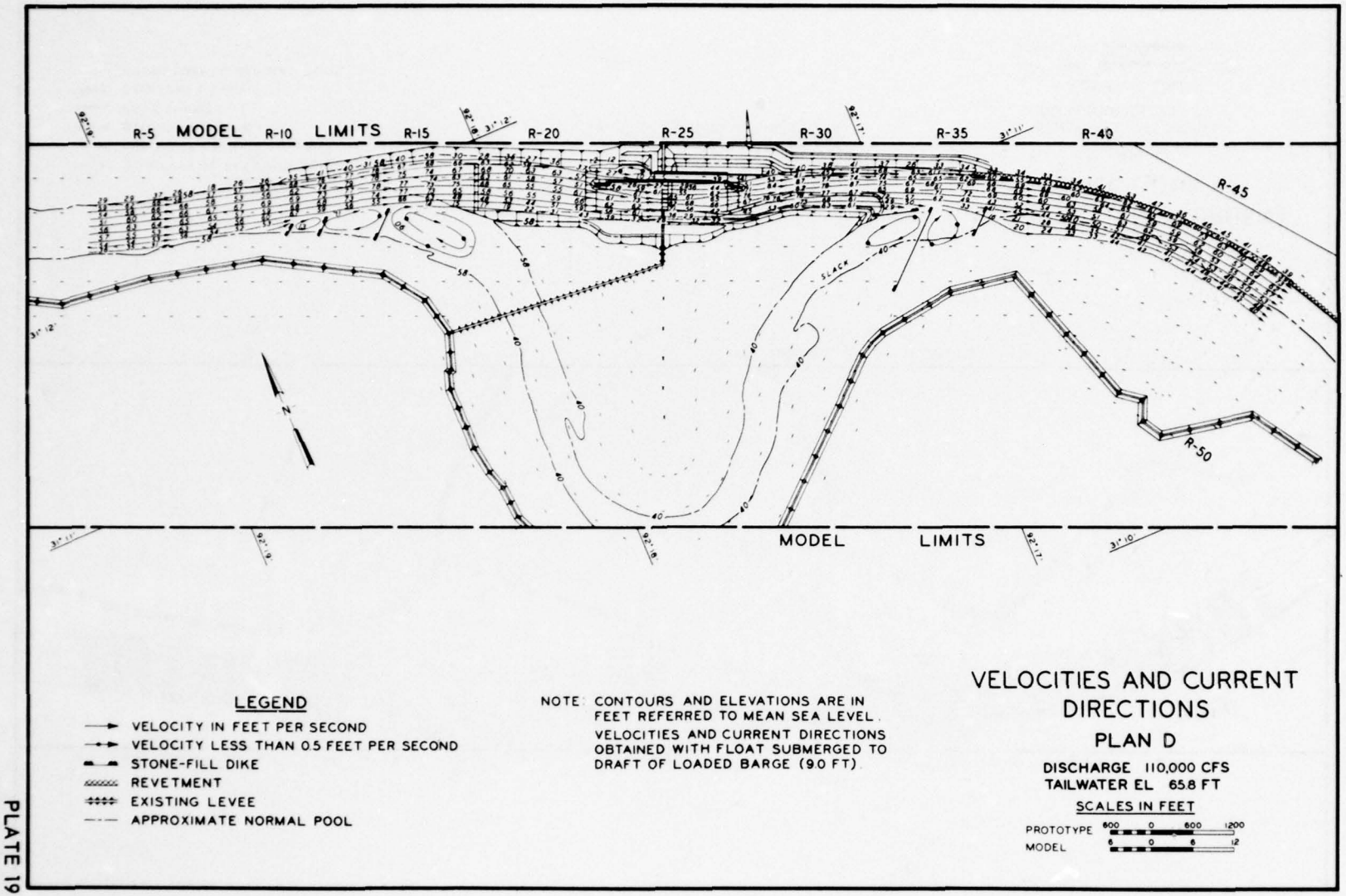
VELOCITIES AND CURRENT DIRECTIONS

PLAN D

DISCHARGE 58,000 CFS
TAILWATER EL 56.2 FT

SCALES IN FEET

PROTOTYPE	600	0	600	1200
MODEL	6	0	6	12



LEGEND

- VELOCITY IN FEET PER SECOND
- VELOCITY LESS THAN 0.5 FEET PER SECOND
- STONE-FILL DIKE
- REVETMENT
- EXISTING LEVEE
- APPROXIMATE NORMAL POOL

NOTE: CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO MEAN SEA LEVEL. VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (9.0 FT).

VELOCITIES AND CURRENT DIRECTIONS

PLAN D

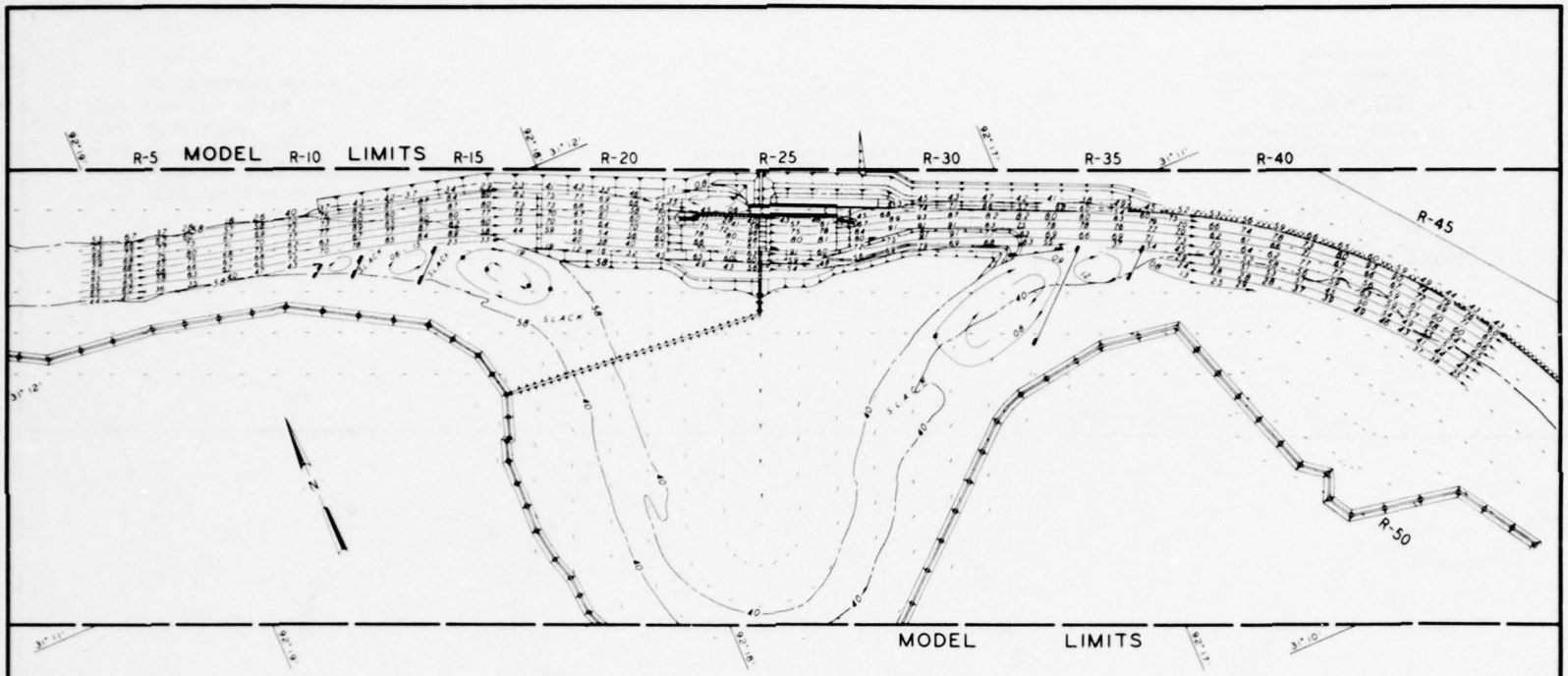
DISCHARGE 110,000 CFS
TAILWATER EL 65.8 FT

SCALES IN FEET

PROTOTYPE 600 0 600 1200
MODEL 6 0 6 12

PLATE 19

PLATE 20



LEGEND

- VELOCITY IN FEET PER SECOND
- VELOCITY LESS THAN 0.5 FEET PER SECOND
- STONE-FILL DIKE
- REVETMENT
- EXISTING LEVEE
- APPROXIMATE NORMAL POOL

NOTE: CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO MEAN SEA LEVEL.
VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (9.0 FT).

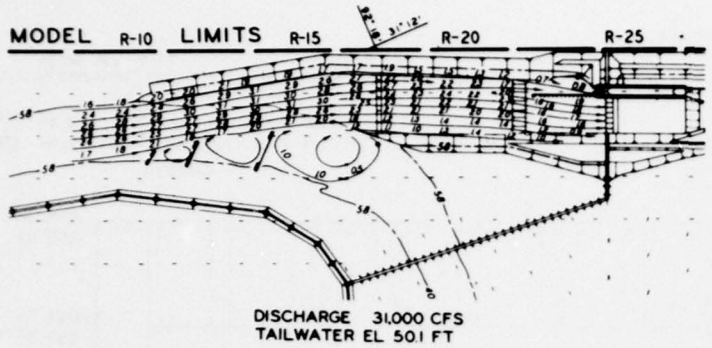
VELOCITIES AND CURRENT DIRECTIONS

PLAN D

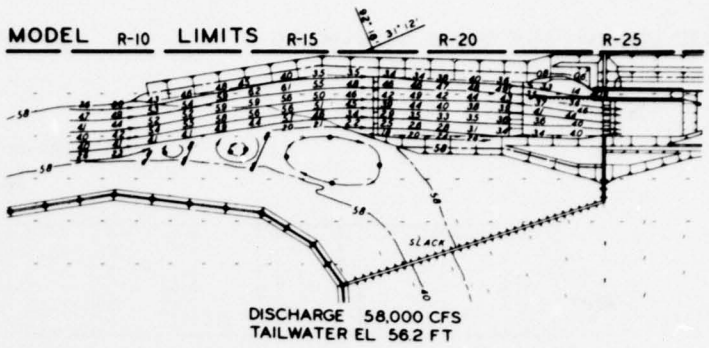
DISCHARGE 145,000 CFS
TAILWATER EL 70.3 FT

SCALES IN FEET

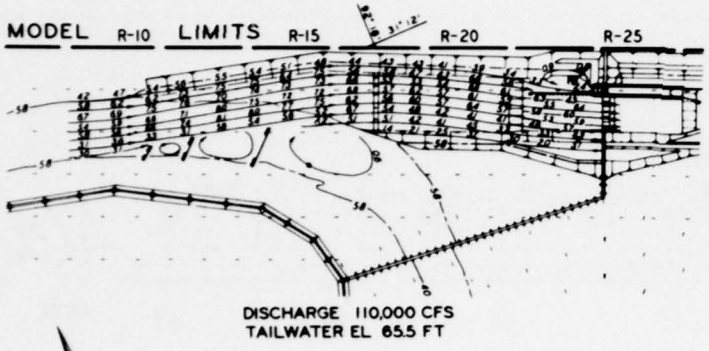
PROTOTYPE	600	0	600	1200
MODEL	6	0	6	12



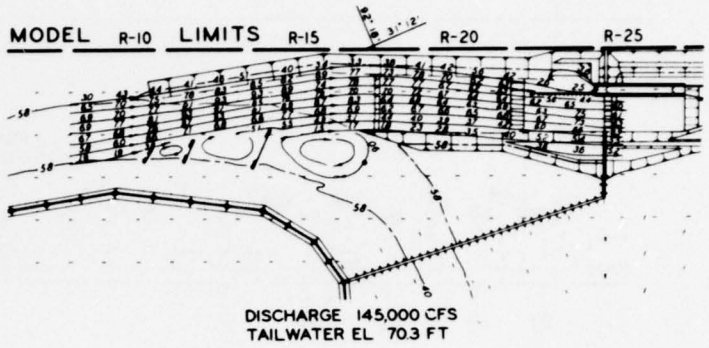
DISCHARGE 31,000 CFS
TAILWATER EL 50.1 FT



DISCHARGE 58,000 CFS
TAILWATER EL 56.2 FT



DISCHARGE 110,000 CFS
TAILWATER EL 65.5 FT



DISCHARGE 145,000 CFS
TAILWATER EL 70.3 FT

LEGEND

- VELOCITY IN FEET PER SECOND
- VELOCITY LESS THAN 0.5 FEET PER SECOND
- STONE-FILL DIKE
- REVETMENT
- EXISTING LEVEE
- APPROXIMATE NORMAL POOL

NOTE: CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO MEAN SEA LEVEL.
VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (9.0 FT).

VELOCITIES AND CURRENT DIRECTIONS

PLAN D - MODIFIED

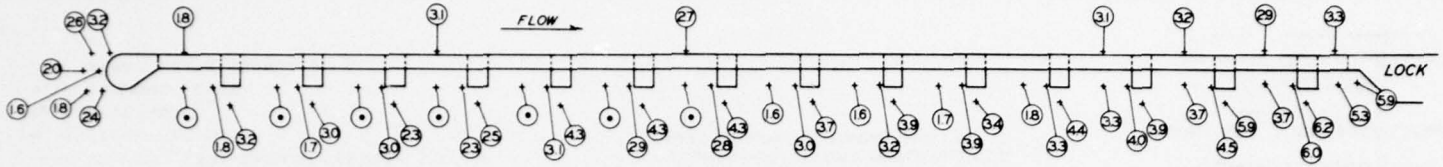
DISCHARGES 31,000, 58,000, 110,000, AND 145,000 CFS

SCALES IN FEET

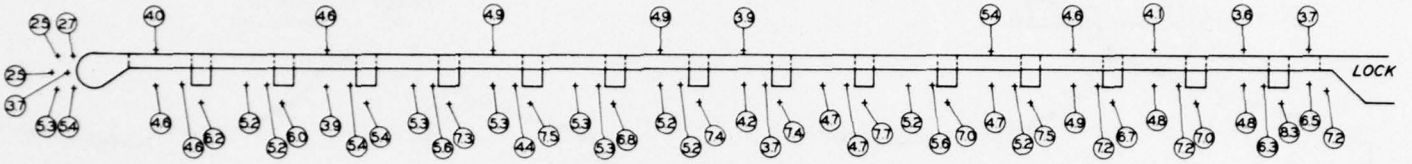
PROTOTYPE 600 0 600 1200
MODEL 6 0 6 12

PLATE 21

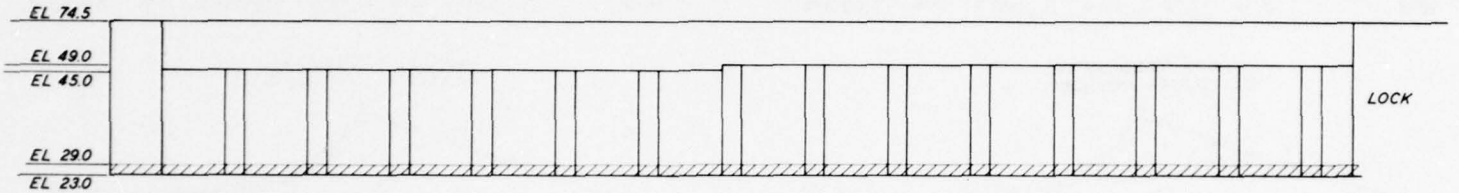
PLATE 22



DISCHARGE 31,000 CFS
TAILWATER EL 501 FT



DISCHARGE 145,000 CFS
TAILWATER EL 703 FT



LEGEND

(17) METER VELOCITIES TAKEN NEAR BOTTOM
(•) METER VELOCITIES LESS THAN 10 FPS

NOTE: ELEVATIONS ARE IN FEET REFERRED TO MEAN SEA LEVEL

ELEVATION

750' PORTED UPPER GUARD WALL

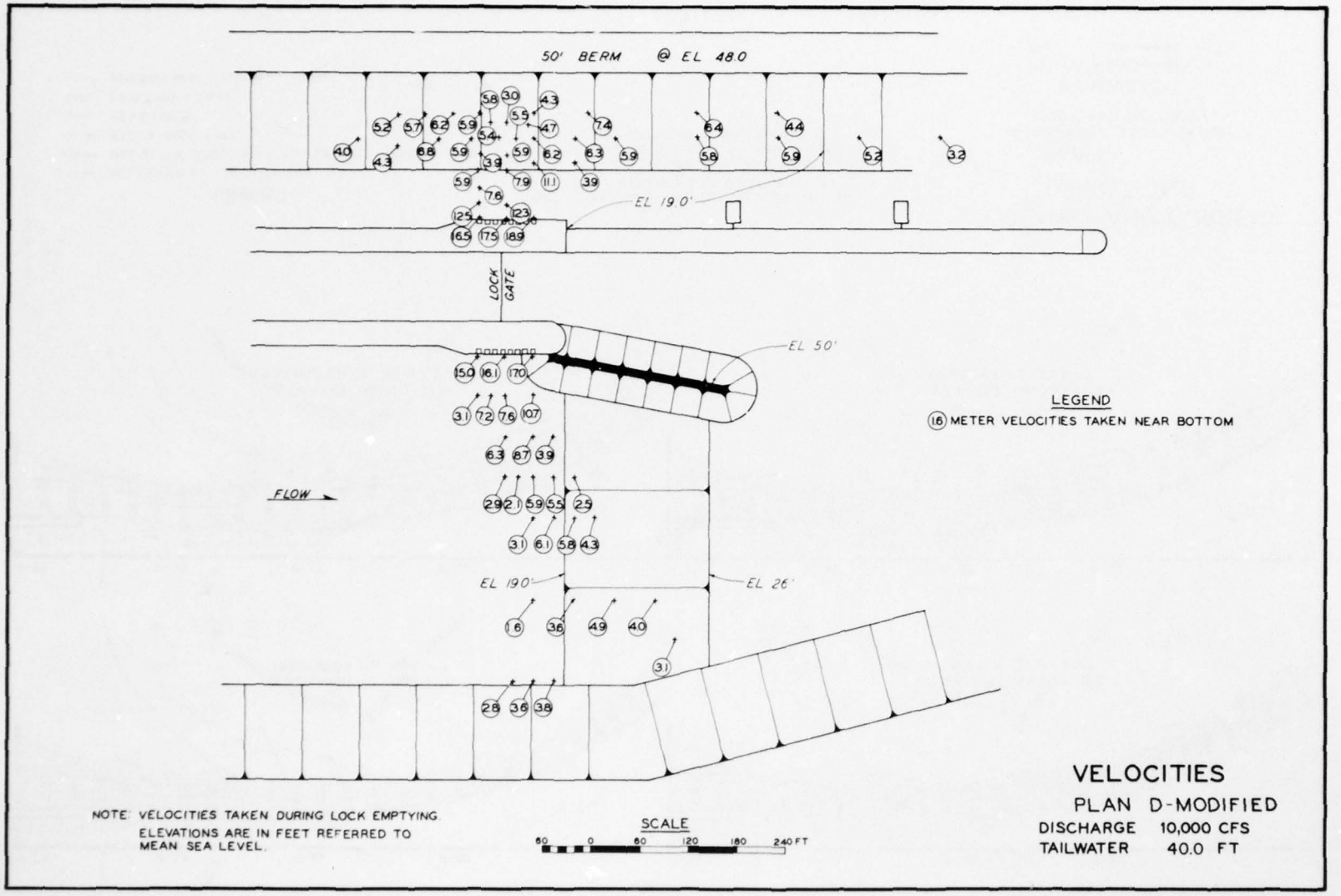
SCALE

30 0 30 60 90 FT

PORT VELOCITIES

PLAN D-MODIFIED

DISCHARGES 31,000 AND 145,000 CFS



NOTE: VELOCITIES TAKEN DURING LOCK EMPTYING.
ELEVATIONS ARE IN FEET REFERRED TO MEAN SEA LEVEL.

VELOCITIES

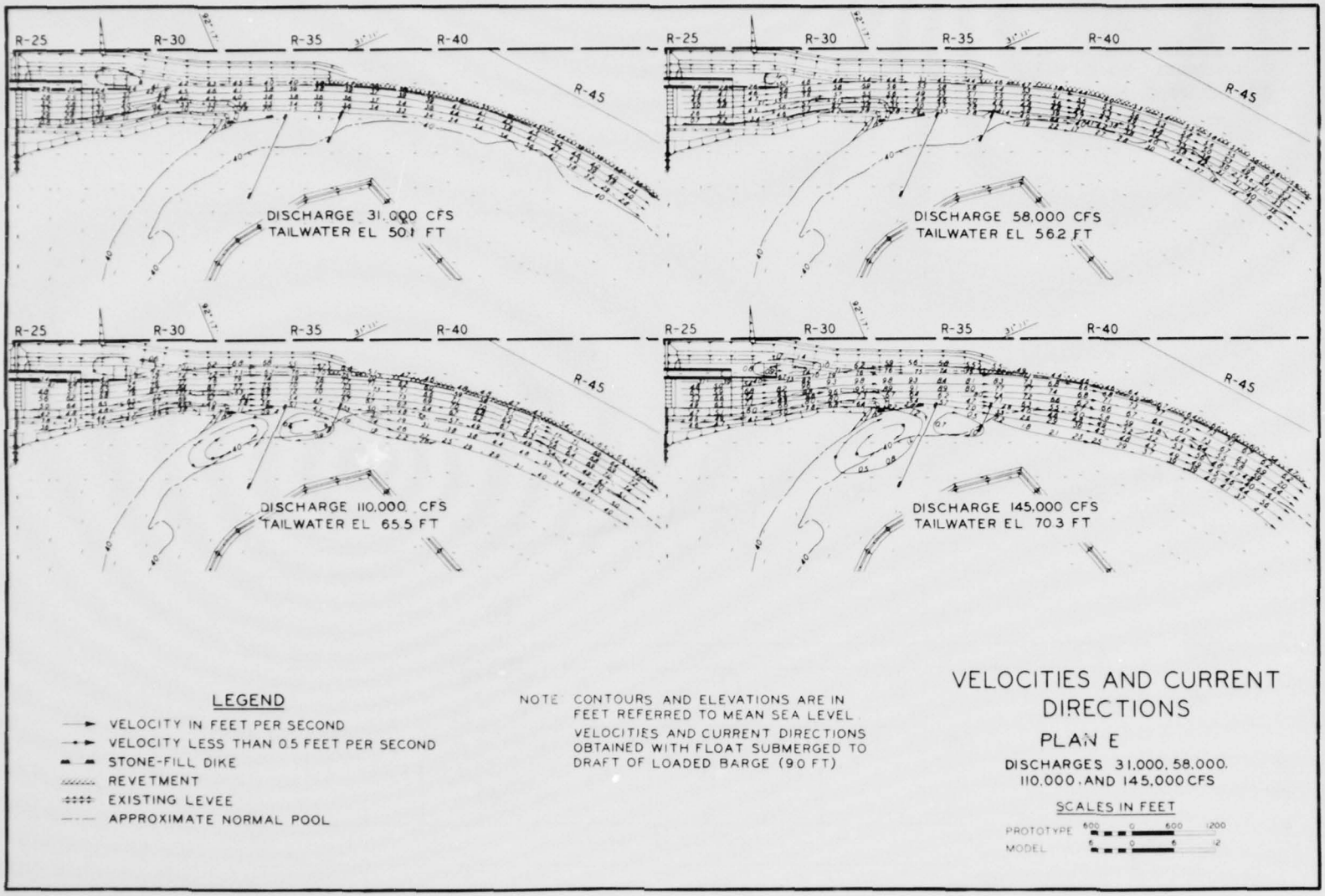
PLAN D-MODIFIED

DISCHARGE 10,000 CFS

TAILWATER 40.0 FT

PLATE 23

PLATE 24



LEGEND

- VELOCITY IN FEET PER SECOND
- VELOCITY LESS THAN 0.5 FEET PER SECOND
- STONE-FILL DIKE
- REVETMENT
- EXISTING LEVEE
- APPROXIMATE NORMAL POOL

NOTE: CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO MEAN SEA LEVEL. VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (9.0 FT)

VELOCITIES AND CURRENT DIRECTIONS

PLAN E

DISCHARGES 31,000, 58,000, 110,000, AND 145,000 CFS

SCALES IN FEET

PROTOTYPE 600 0 600 1200

MODEL 6 0 6 12

In accordance with letter from DAEN-RDC, DAEN-ASI dated 22 July 1977, Subject: Facsimile Catalog Cards for Laboratory Technical Publications, a facsimile catalog card in Library of Congress MARC format is reproduced below.

Shows, Louis J
Navigation conditions at John H. Overton Lock and Dam, Red River; hydraulic model investigation / by Louis J. Shows, John J. Franco. Vicksburg, Miss. : U. S. Waterways Experiment Station ; Springfield, Va. : available from National Technical Information Service, 1979.
36, [19] p., 24 leaves of plates : ill. ; 27 cm. (Technical report - U. S. Army Engineer Waterways Experiment Station ; HL-79-3)
Prepared for U. S. Army Engineer District, New Orleans, New Orleans, La.

1. Hydraulic models. 2. John H. Overton Lock and Dam. 3. Navigation conditions. 4. Red River. I. Franco, John J., joint author. II. United States. Army. Corps of Engineers. New Orleans District. III. Series: United States. Waterways Experiment Station, Vicksburg, Miss. Technical report ; HL-79-3.
TA7.W34 no.HL-79-3